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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

The newspapers relate occasionally stories of passengers who are frightened by the burning of a fuse on a trolley car and who immediately pile over one another in their efforts to get out of the car by doors, windows or any other openings that seem most handy. These occurrences are called "electrical accidents," and the "deadly current" is held responsible for them. They seem to be a survival of the same spirit that prompted the cautious in days gone by to leave their watches at home when they rode on a trolley car—not through fear of pickpockets but because they solemnly believed the watch would be magnetized and ruined if they carried it on board an electric car. What we need is a little general dissemination of common sense among the people on the subject of trolley accidents. The only injury the blowing of a fuse has ever resulted in is to the car, whose woodwork is sometimes ignited, but so far as we can find out passengers have been hurt on such occasions only by themselves or each other.

MATHEMATICS AND ENGINEERING LITERATURE.

The notation of mathematics was invented as a sort of shorthand assistance to thought. Its present use seems very largely to be definable by Talleyrand's famous description of language—a means for concealing thought.

It has come to be the fashion, in papers presented before engineering societies and written for the technical press, to use a complicated and incomprehensible variety of mathematical symbols, often for the expression of the simplest statements. Now it is an axiom that nothing ever was under any circumstances expressible in a mathematical formula that could not as well, if not as briefly, be expressed in the English or any other reasonable language. And further than this, some of the very greatest work in engineering literature and in the expression of science has been done in language which is comprehensible to any person of ordinary intelligence.

If we go back and look at the work of the fathers, of those who laid the foundations of modern engineering and science, we find that in most cases they clothed the thoughts which they wished to present in language so simple that often to-day it stands as an example of clearness of expression. The work of Faraday was probably as far-reaching, as comprehensive and as fundamental as had ever been done; yet his writings are models of simple diction and clear statement. Tyndall did more for science in the English speaking world than almost any one man of his generation, by translating the mathematical labors of his contemporaries into good plain English. This is not to be thought of as in any way a reflection upon the great importance and immense value of mathematical demonstration and expression, but the fact remains nevertheless that with very few exceptions demonstrations, difficult and abstruse when expressed in the formulæ and symbols of mathematics, become clear, evident and satisfactory when written in intelligent language. And they reach a far wider audience; they are more convincing; they go further.

It is betraying no secret to state the fact that a paper before an engineering society, or an article in a technical journal, commands a kind of reverent respect from the uninitiate when it bristles with equations and integral signs; but such papers are listened to by the few and read only by those whose immediate interest tends in their direction.

Take the same subject and the same treatment, put it in plain English, illustrate it with meaning diagrams and note the difference. The young author or engineer is apt to wear his mathematics on his sleeve, so to speak; he feels that the equation is the sign patent of intellectual superiority. When he becomes older and knows more he learns that the greater the labor in preparation of what he has to say or to write, the greater the ease in hearing or reading it and the greater the effect produced.

Once upon a time, in the Island of Nantucket, a retired sea captain conceived the idea of publishing a newspaper. Under the title on the first page he puts the subhead "Good easy reading." That man had the essential and fundamental idea; he knew his business. What he probably discovered in the course of his journalistic career was that good easy reading meant hard and laborious writing. Anybody who knows enough can produce equations indefinitely, and through their agency sometimes arrive at conclusions of value. But those who know a little more will translate their equations into words, will boil down the words until the residuum is refined and clarified and clear to that point that it is transparent, and then the result will become of value and the author will be hailed as one who shows the way to new things.

It is not going too far to say that no great advance in engineering or in science has ever been made to impress itself upon the thinking world through the agency of a symbolism which was not understood of all men.

THE FUTURE OF THE AUTOMOBILE.

To those who are interested in the history of industrial developments the career of the electric automobile presents no novelty. Indeed, history has a habit of repeating itself and the last few years of the exploitation of electric vehicles has exhibited once more the spectacle of a new industry damaged in the house of its friends by an over-confident attitude of mind on the part of investors, and a tendency toward over-satisfaction that seems inevitable in such enterprises. In addition to these troubles it may frankly be stated that the electric automobile has not proven itself satisfactory in competition with steam and gasoline-driven vehicles.

The reason is patent to every one who has had experience with electric vehicles. While every detail of the control, the management and the motive power of these automobiles is satisfactory, yet the essential element, the storage battery, has been a source of weakness and trouble. Batteries have suffered from one or the other of two difficulties, forming the horns of a peculiarly unpleasant dilemma. Either they have been so heavy as to leave little extra capacity on the vehicle for passengers and freight and to cause the radius of operations on a single charge to be too small for satisfactory use, or else the batteries have been lightened and fined down to such a point as to make them unreliable in service. The cost of maintenance and replacement has been also unavoidably high, so that despite the natural perfection of electrical methods of operation, the electric automobile has not found the favor with which the public has greeted its rivals.

But it is conceded that, given the proper storage battery, the electric automobile will have no real rival. There is open to it a field of the utmost importance in the transportation of merchandise in cities. The trucking business of a great city is of surprising extent and importance. The charges paid for vehicle delivery of freight are, relative to those for the handling of the same freight on railroads, absolutely enormous and out of all proportion. It costs often as much to deliver a package from a place of business in New York city to the railway station as it does to forward it thence to Boston or to Chicago. With proper batteries electrical vehicles could compete, with the practical certainty of entire success, for this class of business and also could be made very useful as public cabs and for the delivery service of retail establishments.

Viewed in this light, and seeing that there is made to hand a field for the profitable use of these vehicles, is it likely that we shall long remain in want of the proper storage battery? Indeed it has already been promised and it is urgently to be hoped that the promises made may be entirely fulfilled, as now seems likely. Given this essential element it is no stretch of the imagination to conceive of a horseless city, clean and reasonably silent.

THE COMMERCIAL ASPECT OF WIRELESS TELEGRAPHY.

At a meeting of his company in England last week Mr. Marconi announced that there were in use at present twenty-five permanent land stations for wireless telegraphy and that seventy ships were now equipped with apparatus on his system. Doubtless this figure does not include the ships equipped with other varieties of wireless telegraph apparatus, of which there are several of German, French and American origin. He is also stated to have said that the commercial speed of operation is at present twenty-two words per minute.

Despite the fact that it was announced in the newspapers last week that a considerable railroad system in Texas is about to experiment with wireless telegraphy as a permanent installation for train despatching and other purposes, it is believed today that the future success of this means of communication will not be in the direction of land-line work. In the first place a telegraph line is so cheap to construct and so entirely satisfactory in its operation, permitting also the use of telephones upon it, that the important element of cost does not enter so largely in determining the choice of a system as in the case of wireless telegraph *versus* ocean cable. It is particularly in connection with marine signaling that wireless telegraphy will probably find its field, and especially in the somewhat wide direction offered by the equipment of moving ships with signaling apparatus. For this purpose there is nothing to compete with the wireless system.

The idea of supplementing the lighthouse service on a coast by means of electric wave signals which penetrate the densest fog and reach to great distances in all varieties of weather is certainly most attractive. There can be no doubt that stations of this kind will be a most important auxiliary of the lighthouse service and will greatly increase the safety of navigation. The establishment of a station for reporting ships on the Nantucket Shoals lightship, which was first suggested in the ELECTRICAL REVIEW, has already been of no little value to shippers and others in the port of New York. Through its agency news of incoming ships is received more than ten hours earlier than formerly, and vessels may report in stormy and foggy weather, which was not the case when it was necessary for the marine observers to see and distinguish the ship.

For purposes of communication with islands or across fairly wide bodies of water where the expense of a cable or difficulties connected with its laying would be prohibitive, wireless telegraphy offers an excellent means. Whether or not it will ever be used for the handling of commercial messages across the Atlantic is a question which must be left to the future to decide, but this use certainly looks doubtful, to say the least. The total capacity of present cable systems is about a thousand words a minute, both ways, while the capacity of any wireless system would, apparently, necessarily be smaller.

Sometime ago it was suggested in these columns that no good name for wireless telegraphy had yet been invented, the term "wireless telegraphy" itself being a misnomer and altogether too long and complicated to remain long in use. A number of interesting suggestions for a name have already been received, among them such words as "atmography," "etherography," "conigraphy," "syntography," "ethergraphy," etc. Here is an opportunity for ingenuity, and also to coin a word of general utility. Suggestions for a proper name are cordially invited.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LVIII.

BY W. ELWELL GOLDSBOROUGH.

The total reactance electro-motive force is equal to

$$I^b (x_a + x_1{}^b).$$

Part of it is, therefore, developed in the armature winding, and part is due to the reactance x_1 of the receiver circuit. Since the armature reactance x_a is a constant, the value of I x_a will diminish proportionally to the value of the current. Accordingly, as the armature reactance electro-motive force diminishes, its vector $A_0C_0{}^a$ also diminishes, and its vector head C^a will trace out the arc $C_0{}^aF^b$, bringing the armature reactance electro-motive-force vector into the final position A_0F^b, which is equal and parallel to the vector $C_a{}^bA_a{}^b$, already constructed. The extension of the vector A_0F^b from F^b to $C_0{}^b$ represents the value of the reactance electro-motive force of the receiver circuit, which, from an initial value equal to zero, increases to the value $C_0{}^bF^b$ equal and parallel to OQ^b (see Fig. 145), as x_1 increases.

Thus far, we have neglected to consider the reaction of the armature currents.

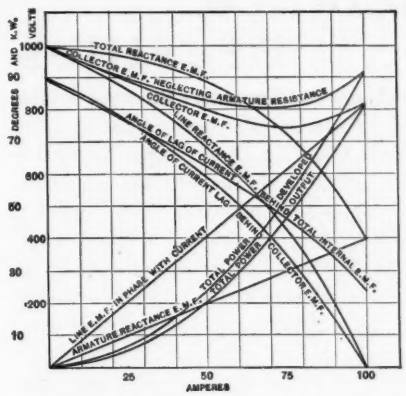


FIG. 143.—ALTERNATING MECHANISMS.

As the phase and value of the current, and the phase and value of the armature flux vector M_0M^a will undergo the same change, M^a will move to the new position M^b, giving the armature flux vector M_0M^b, parallel and proportional to OB^b. The resultant flux enclosed by each armature coil will now be represented by the vector OM^b. This vector has a phase position that is 90° in advance of the vector OF^b, OF^b being the electro-motive force which overcomes the impedance made up of the total ohmic resistance of the circuit $r_a + r_1$ and the external reactance x_1. The armature current induces a field which, during its cyclic variation within the armature coils, produces a reactive electro-motive force A_0F^b. Therefore, when the machine is under an inductive load, the electrical pressure represented by the vector OA_0 is never apparent in the armature windings. The total value of the electro-motive force actually developed in the armature windings is represented by the vector OF^b, and it is developed in the armature coils by the resultant flux which undergoes a cyclic variation through those coils. Thus the resultant flux, which produces the maximum actual electro-motive force developed in the armature coils, provides an electric pressure sufficient to overcome the impedance of the external circuit and the resistance of the armature.

In Fig. 142, there is developed, somewhat more in detail, a vector diagram illustrating the regulation of a single-phase alternator under an inductive load. The letters (*a*), (*b*), (*c*), (*d*), indicate the successive relative positions assumed by the vector quantities, as the external inductance x_1 is given successively increasing values. This diagram shows that as the inductance x_1 is increased the current diminishes in value, but that

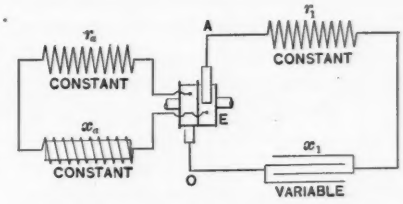


FIG. 144.—ALTERNATING MECHANISMS.

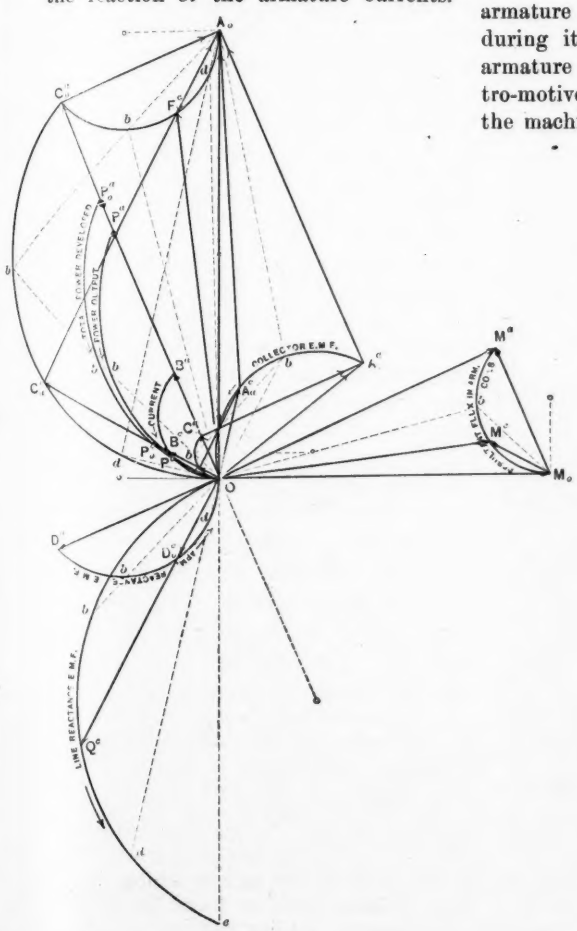


FIG. 142.—ALTERNATING MECHANISMS

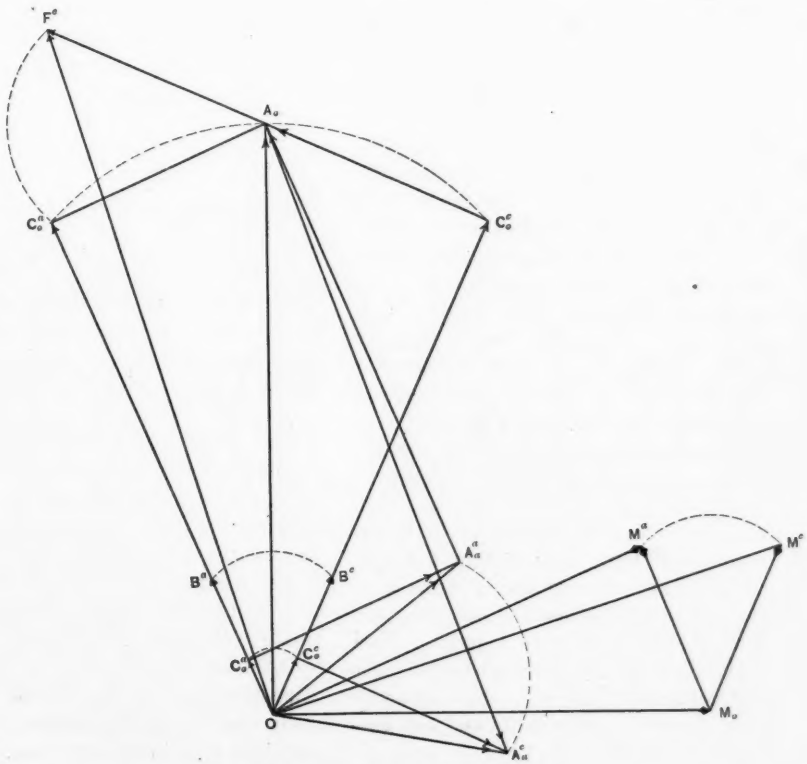


FIG 145.—ALTERNATING MECHANISMS.

the electro-motive force apparent at the collector rings (in the main) increases in value. One peculiar property of a variable inductive load is to cause an initial decrease in the electro-motive force apparent at the collector rings, which is supplemented by an increase, after the point of minimum collector electro-motive force is passed.

In Fig. 143, this fact is illustrated somewhat more definitely. It is here seen that when the current decreases from its initial value equal to $o\ a$, the external electro-motive force decreases until the current reaches a value $o\ e$, after which it steadily rises until the no-load value is attained. Fig. 143 shows the characteristics of the alternator plotted in rectangular coordinates. It is drawn by plotting the polar vectors of Fig. 142 relatively to the successive current values.

In Fig. 142, the power vectors are shown in phase with the successive positions of the current, inasmuch as the total power developed equals $P_0 = I^2 (r_a + r_1)$. Accordingly, the maximum power developed by an alternator occurs when the inductance of the external circuit is zero, providing the external resistance remains constant. Under an inductive load of constant resistance, the electrical efficiency of an alternator remains constant, since it is equal to

$$100\ [(I^2\ r_1) \div I^2\ (r_a + r_1)].$$

By comparing the phase diagrams presented in Figs. 134 and 142, we get a better insight into the reactions of the armature currents against the field circuit. When a machine is loaded non-inductively, we see that the armature reaction more and more nearly opposes the field magnetism as the resistance diminishes, and, in so opposing the field magnetism, constantly increases in value. Now, when the inductance of an external circuit of constant resistance is increased, the armature currents tend more and more nearly to a phase position, in which they diagrammatically oppose the field circuit. In so doing, however, they constantly become weaker until, finally, just when they are in direct opposition to the field magnetism, they become zero.

Accordingly, in Fig. 138, we see the armature coils in a position in which the current is a maximum when the conditions are such as to produce the (*a*) vector positions of Fig. 142, while, in Fig. 139, the teeth and coils are shown in the position of maximum current at the time when x_1 has become very large. This position, it will be remembered, is also that occupied by the coils when the armature current is a maximum and the generator short-circuited.

Science Brevities

Primary and Secondary Rœntgen Radiation—When the Rœntgen radiation from a focus tube falls upon the surface of certain solids, the surface becomes the source of a secondary radiation. Both primary and secondary rays render a gas through which they pass a conductor, but while the primary rays suffer very little absorption the secondary rays are almost entirely absorbed within a few millimetres at atmospheric pressure. H. S. Allen has compared, in an English contemporary, the total ionization produced by the secondary rays with that which would be produced by the primary if they continued their path in the original medium. Then supposing that the total ionization, if not equal to, is at least proportional to the energy of the radiation, a measure of the ratio of the energies in the two kinds of radiation is obtained. The experiments involve two separate determinations. In the first place, the ratio of the total ionization caused by the secondary rays to that produced within a known space by the primary; and secondly, the absorption experienced by the primary rays in traversing a known distance. The comparison of the ionizations was made by Perrin's method, in which the rates of leak from two condensers are compared, the leak in the first being due to primary radiation alone, and that in the second to primary and secondary radiation. The determinations have only been completed in the case of sulphuretted hydrogen, and they show that the total energy of the secondary radiation only amounts to about one two-thousandths part of the energy of the primary radiation.

Nickel Amalgam—Chemical research has not yet decided, says the *Electrician* (London), whether the amalgams of iron, cobalt and nickel are mixtures or compounds. The amalgams of iron and cobalt have been studied by Nagaoka, but not that of nickel. Iron and cobalt amalgams are strongly magnetic at ordinary temperatures. The magnetization increases with the magnetizing field and with the percentage of the magnetic metal. At low temperatures, both the magnetization and the remanent magnetism are less. H. Wünsche is strongly of opinion that in the case of nickel amalgam a chemical combination of nickel and mercury must be assumed, as it shows an extraordinary low magnetization. If the nickel were not really dissolved in the mercury, but were contained in it in the free state, the magnetism of the nickel amalgam would have to be somewhat in proportion to the percentage of nickel in it, but this is not at all the case. Sometimes amalgams containing little nickel are found to be more magnetic than amalgams containing much nickel. This depends upon the manner in which the amalgam is prepared. The author usually prepared it by the electrolysis of nickel sulphate in neutral or acid solution, but also found it advantageous to use a mixture of nickel and ammonium sulphates, ammonia and water, so as to get rid of any iron impurities. A 3.75 per cent amalgam showed an intensity of magnetization of 0.0636 unit with a magnetizing force of 120,637 C. G. S. units. This gives the very low susceptibility of 5×10^{-4}. In spite of this, the amalgam showed a very high remanent magnetism. No change is produced by reducing the temperature to —78 degrees. The magnometric and ballistic methods of measurement were not available for these investigations, and the author therefore measured the traction exerted by the magnetic field upon the amalgam.

A New Quadrant Electrometer—It is probable, owing to the disturbing influence of magnetic forces, the galvanometer has reached the limit of improvement. For this, as well as for other reasons, it is desirable that the electrometer should be brought up to the same high standard of efficiency. The chief difficulty in the way of improvement in the quadrant electrometer is the necessity of charging the needle. If this is done through the suspending wire, the latter offers a considerable turning moment, unless it is made of silvered quartz fibre which, however, is exceedingly difficult to prepare and manipulate. F. Dolezalek, therefore, suggests, in an abstract from a foreign contemporary, the use of a quartz fibre rendered slightly conducting by dipping into a solution of some deliquescent salt, such as calcium or magnesium chloride. The conductivity thus acquired is practically permanent, and is sufficient for charging the needle. The latter is of the lightest kind, made of "silver paper"—*i. e.*, paper covered with a layer of zinc and cut into the form of the usual needle. In the actual instrument the quartz fibre is 0.009 mm. thick, and the needle has a period of oscillation of eighteen seconds. The instrument measures a difference of potential of 0.001 volt within ten per cent and 0.1 volt within two per cent or less. The author also tried to avoid the use of a conducting fibre altogether by suspending with the needle a small dry battery which would keep it charged, but he found the battery got exhausted in a few months.

The Protection of Lines and Apparatus from Electrostatic Strains.

A Lecture Before the American Institute of Electrical Engineers.

(Continued from last week's issue.)

CHARGING A SHORT TRANSMISSION LINE.

Consider the charging of a short transmission line. The line may be considered to be a condenser; assume that it is being charged from bus-bars rigidly maintained at constant potential. There will always be a certain amount of inductance in the path through which charging current must pass to reach the line, so that we have the case of the charging of a condenser through inductance with more or less resistance in the circuit. Therefore, when the line is connected, it rises to double potential (neglecting losses) and immediately starts to oscillate between this point and zero until the oscillation gradually dies out and leaves the line at normal potential.* This means that at all points the insulation of the line will receive a strain of double potential. If, on the other hand, the bus-bar from which the line is charged has not the capacity to deliver almost instantly the amount of electricity necessary to charge the line, the first effect of closing the switch will be not to raise the potential of the line to its full amount, but to make both line and bus-bar take an intermediate potential so that the line comes up to normal potential by steps. Under these circumstances the maximum of the oscillations is materially reduced, and the line is not subjected to double potential. In the extreme case in which the bus-bar has a comparatively small capacity to deliver current, the first effect of connecting the line is to bring the potential down to zero. In this case, if the line be charged from transformers, the outer portions of the windings are subjected to severe strains, as already explained. For a bus-bar to be able to supply charging current to a "dead" line so quickly as not to have its potential momentarily dropped, it must have the necessary amount of electricity already stored in condensers connected directly to the circuit. In commercial plants the place of such condensers is supplied by other live lines connected to the bus-bars.

The strain of double potential produced by charging the line has an interesting analogy. If a piece of metal be tested for tensile strength by suddenly applying a weight on the end, a double strain will be momentarily given the metal due to the slight motion of the weight allowed by the stretching of the test sample. In this case the inertia of the weight corresponds to the inductance through which the line is charged.

The discussion so far assumes that there are no losses of energy in resistance or in currents set up in adjacent bodies. Such losses, which always exist to some extent, tend to reduce both the amplitude and the number of oscillations.

CHARGING A LONG TRANSMISSION LINE.

In the case of a long transmission line, however, the line can not properly be considered to be a simple condenser, for this is equivalent to the assumption that the line is so short that its inductance is practically zero, and in actual long lines such is not the case. To present such a line, however, we may take a succession of choke coils and condensers connected in series, as in Fig. 1. Consider a single line wire open-circuited at the receiving end.

The "dead" line is to be charged at the end, B, from the high-tension bus-bar, A. Assume that, as the switch at A is closed, the point, B, is instantaneously raised to full potential. If now the line extended no further than the condenser, C, we should have the case of a short line which has just been discussed; that is, the line will rise to double potential and oscillate until it finally settles down at normal potential. But since the line shown in Fig. 1 does not end at C, as soon as the potential of condenser, C, begins to rise, current begins to flow to condenser, D, and as C rises higher and higher, more and more current will flow to D. The potential of D then begins to rise, which starts current to E, etc. As D rises slowly at first, C reaches bus-bar potential before D, and similarly D before E, etc. As soon as C reaches this potential it remains constant. At the same time that C reaches bus-bar potential the current value in the coil between B and C reaches a maximum and becomes constant. Similarly with the currents in the other coils. This current, which has a constant value in more and more coils, as the line charges up, represents the charge that is being added constantly at those points where the potential is changing. Though the potential of C remains constant, that of D continues to rise until it reaches the same value of C, when it, too, becomes constant, though the potential of E continues to rise, and so on along the line. Similarly with E and F, but each successive condenser reaches its maximum a little behind those nearer the point, A, so that the net result is a wave of electro-motive force starting at the point, B, and passing along the line.

The general distribution of the potential of the line showing the wave form at short intervals of time after connecting on the line is shown in Fig. 4.

This wave passes along leaving the lines fully charged. If the line be infinitely long it will experience no further disturbance, and if there are no resistance or other losses the wave will pass along the line an indefinite distance, keeping its form and raising in turn all parts of the line to the full bus-bar potential. If there be considerable losses of energy as the wave proceeds (as there usually are in any actual circuit) this wave will lose its shape somewhat, and will get feebler and feebler, until, if the line be long enough, it ceases to be perceptible. This dying away of intensity may be slow enough in commercial lines, so that a large part of the original intensity of the wave will remain when the end of the line is reached. Now the end of the line is open-circuited and the wave of electricity can go no further and is reflected back. At the reflecting point the maximum potential reached is twice that of the wave.

On being reflected, the wave immediately starts back along the line, leaving it charged to double potential (assuming no losses), and finally reaches the starting point, A, where its energy is absorbed by the bus-bar. But the line can not stay at double potential, and a second wave is sent along the line, bringing it back to normal potential again. This second wave will be reflected at the open end, and will return again, but this time dropping the potential of the line to zero potential until, as the wave reaches A again, the line is practically in its initial condition. This wave, in turn, is absorbed by the bus-bar, and the whole series of opera-

* This rise of the line to double potential on charging was mentioned in Mr. Steinmetz's paper before the Institute last August.

tions gone over again and again. If, however, there are resistance and other losses the wave is growing thinner and thinner all the time, and finally dies away, having only partly charged the line. As the wave dies down by the resistance losses an infinite number of small supplementary waves are sent out, which complete the charging of the line. If there are no losses, however, no supplementary waves will be found.

It will thus be seen that the charging of a long line is much the same as a short line; in both cases the line oscillates between zero and double voltage until the losses cause it to settle down at normal potential. These wave changes are indicated in Fig. 4.

Actual tests on commercial transmission lines suddenly charged have shown a rise of potential much greater than normal at the end farthest from the switching.

Suppose a stretched flexible cord fastened at one end and held in the hand at the other. A quick motion of the hand sideways will send a loop or wave along the cord which will pass to the end, will be reflected back and will finally reach the hand again. This wave is analogous to a static wave of the transmission line.

CHARGING A BRANCH LINE.

Consider a line consisting of two parts —the more remote having a much smaller capacity and larger inductance than the nearer. When a wave starting from the beginning reaches the junction it will be partially reflected, since the whole charge of the large line can not be crowded into the capacity of the small line, especially in view of the increased inductance of the new position; that is, there will be a rise of potential at this point and a wave smaller than the outgoing wave will start back. As the original wave will not be wholly reflected, the potential at the juncture of the two circuits will not be double the charging voltage.

But a wave will also be sent forward into the second part of the line which will have a crest as high as the maximum of the potential at the reflecting point. Therefore, at the end of the second line, where another reflection occurs, the crest of the last wave will be doubled. The resultant potential at this point will thus be very high, but not over four times the original voltage of the bus-bar. It may be much less. This means that a branch line at the end of a main system (especially if the latter consist of two circuits in multiple) will receive a very severe shock at the farther end when a wave enters it from the main line. This is a case that may readily occur in actual plants and should be carefully considered. If there be a third line on the end of the second leaving a still less capacity and still greater inductance a wave will be formed in this line whose crest has the value of the maximum rise of the reflecting point at the end of the second section of line, and which will double its potential at the farther end as before. This last rise of potential has as its maximum theoretical limit eight times the original charging voltage, but would actually always be much less. This case is very unlikely to occur in actual circuits. The total energy of the waves in the second

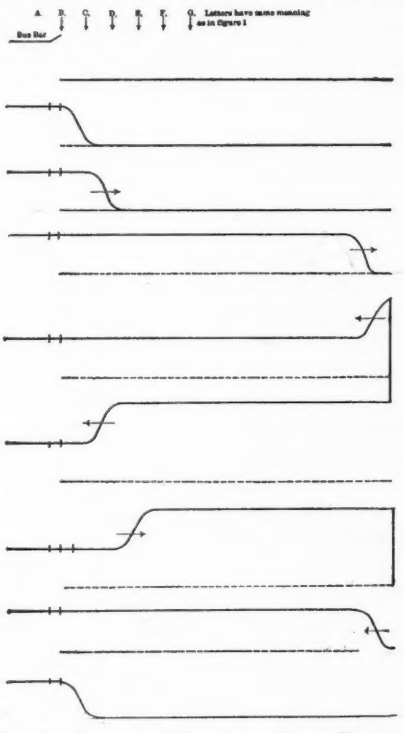


FIG. 4.—CHARGING WAVE IN A LONG TRANSMISSION LINE.

and third sections of lines is much less than in the original wave, but it is at a higher potential.

To return to the consideration of the uniform circuit. It has been shown that when one end of a long line is suddenly raised to a certain potential and maintained there, a wave of charge passes along the line, leaving it charged, and that when this wave reaches the open end of the line it is reflected and produces all along the line a potential double that of the bus-bar. If, however, a sine electro-motive force be momentarily applied to the line so that the end of the line is not maintained steadily at the full potential as before, but is immediately lowered, a wave will be found in the line as before with the same maximum voltage but a different form. (See Fig. 5.) This wave leaves the line uncharged. The rise of potential at the reflecting point, however, is the same as long as the crest of the wave is the same, but in this case only the reflecting point receives double potential (assuming that only a single wave is started in charging).

If a wave be started at one end in a very long, narrow trough of water, it will proceed the length of the trough, and on reaching the end will be reflected and will rise up to double height at the reflecting point. This wave in the water is again analogous to the wave of charge passing along the line, leaving it unchanged and causing a double strain at the reflecting point.

In all cases of static effects the change in electro-motive force of the bus-bars due to the generator is so slow that the generator electro-motive force may be considered constant while the static phenomena are taking place.

The length of the wave in the line is determined by two factors—the speed at which the charge passes along the line and the time required to bring the potential of the first point of the line to full potential; it is the extreme distance to which the charge has penetrated when the charging potential becomes stationary.

If the line is shorter than the length of the wave no complete wave will be formed, but reflection will produce the same rise of double potential at the end. The speed at which the wave will pass along the line is inversely proportional to the square root of the product of the capacity and the inductance per unit length (unit length = 1 earth quadrant = 6,200 miles); that is, to the time constant. But on air lines the waves always travel at approximately the speed of light, so that there is an inherent relation between the inductance and capacity of an air line which at first thought is very surprising. This relation is expressed by the equation $v = 1/\sqrt{L\,C}$, or $L = 1/v^2\,C$ where v is the velocity of the wave in air.

Evidently the more sudden the disturbance the more likely is the formation of a complete wave. In the extreme case when the length of wave is very much longer than the line (as in the case when the voltage is applied to the line very slowly) there is practically no wave formed and we have the plain charging of a condenser. This is also the case considered in discussing the charging of a short transmission line.

If the source of electro-motive force from which the line is charged can not maintain rigidly its potential during charging, the line will be charged up by

steps as already explained. The result is that a weaker wave is obtained followed by a second wave as the bus-bar recovers its potential, which completes the charging of the line.

CHARGING A MULTIPLE CABLE*.

. What has just been said of charging a line applies equally well to an underground cable, only the cable has a much larger e. s. capacity and a smaller inductance than the transmission line. If a wave of potential be formed in charging the cable the wave will be reflected at the end, causing double potential all along the cable as it returns to the starting point. If, however, the cable be so short that no wave be formed the cable will be charged like a short line, that is, as though it were a condenser. As before, if a momentary impulse up and down be given the cable instead of a steady charging voltage, a wave of the form shown in Fig. 5 will be produced which causes double potential at the end of the cable and there only when one impulse is sent into the cable.

If a steady alternating electro-motive force is applied to the line, waves will be sent along having crests of positive and negative values alternately and will be reflected at the end of the line one after another and return toward the starting point. When a returning positive crest meets an advancing positive crest double potential will result at the point of meeting; similarly with two negative crests. When a positive and a negative crest meet, zero potential will result at the point of meeting. The result is the formation of nodes and loops in the line or cable, that is, points of zero and of double potential, as shown in Fig. 6, where advancing waves are shown full, reflected waves dotted, resultant nodes and loops in dot and dash.

The waves sent into the line by the alternating electro-motive force are in continuous motion back and forward, but the nodes and loops are fixed in position though the loops vary in strength, alternating between positive and negative. This phenomenon is similar to the formation of nodes and loops in an organ pipe. There is always a loop or point of double potential at the reflecting point. The distance between two positive loops at any instant is the wave length of the moving waves.

To this point the lines and cables may have been considered as open-circuited at the farther end. Comparatively little difference will result in static effects, however, if they be closed through transformers at various points, for the inductance of the transformer winding is so great that the comparatively large quantities of the charge on the line would not be materially lessened by the e. s. capacity of the transformers. In fact the transformer is subjected to a very severe strain without its being able to relieve the line. This strain is similar to that produced by connecting a "dead" transformer to a live line, since the rise of potential of the transformer terminal, due to reflecting the wave, may be very abrupt.

OPENING A HIGH-TENSION CIRCUIT.

When opening a load current in a high-tension line or cable no rise of potential will result unless the current be suddenly interrupted. With such an interrupter of

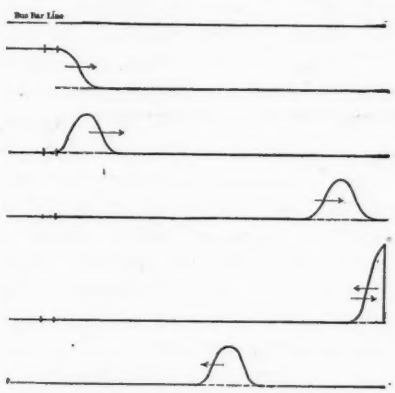


FIG. 5.—CHARGING WAVE IN A LONG TRANSMISSION LINE.

course (as all commercial circuits contain considerable inductance) a rise of potential will result, its severity depending upon how suddenly the current is interrupted, how much magnetic energy is stored in the circuit, and how much e. s. capacity exists in the neighborhood of the break. This matter was treated by Mr. Steinmetz in his paper before the Institute last August. He there states that an excessive rise of potential may be expected from the interruption of short-circuits. As a matter of actual experience it is the opinion of the author that little harm actually results from the opening of load or short-circuit currents in commercial systems, as the resulting arc can not drop out suddenly on account of the great amount of heat generated. There are often, however, other causes of static strains which may result from short-circuits, that occur at practically the same instant of time and in some cases the results of the one may be assigned to the other.

However, by opening an unloaded line or cable, it is entirely possible to obtain a rise of potential as follows: On opening a switch to cut out an unloaded line the arc of the charging current tends to drop out when the current strength is zero, that is (since the unloaded line takes a leading current) when the voltage is a maximum, for as the line will momentarily hold its charge there is at this time a little difference of potential between the line and bus-bars, even after the switch is opened. The line is thus left charged when the switch is opened while the potential of the bus-bars is changing with the generator electro-motive force. When the voltage of the generator has passed through one alternation there will be a potential between the line and bus-bars which may be sufficient to cause the arc to establish itself again and recharge the line. The arc will again drop out when the current becomes zero, and this action may be repeated several times before the line is finally clear. The sharp crackling sound often accompanying the switching out of a high-tension line or cable suggests this phenomenon. This recharging of the line will cause the formation of a wave and the consequent rise of a potential as in the case of a charging line. Thus, pulling off an unloaded line may have the same effect as charging it so far as the static rise of potential is concerned.

In the case where one terminal of the single-phase generator is grounded and charging current is opened at the other a static wave is produced in the line of double the intensity caused by charging the line "dead," that is, a strain of double line voltage.

OTHER CAUSES OF STATIC STRAINS.

In the previous discussion I have endeavored to show that dangerous static effects result directly from very abrupt changes of potential. They may appear in parts of the circuit very remote from the exciting cause. These static strains are phenomena, such as would be expected to result from well-known laws governing static electricity. In addition to the causes of abrupt changes of potential already discussed a few more will be briefly described.

(*a*) Short-Circuits—A short-circuit between the two line wires when of a sudden nature causes an abrupt reduction to zero of the potential of one or both lines at the point of short-circuit. This is the reverse of the case of charging a line. A wave is sent along the line causing a dropping of the potential, which of course has no tendency to ground apparatus. Nevertheless, this wave causes just as se-

* By multiple cable is meant a cable containing two or more insulated conductors.

vere a strain on the insulation between turns of the transformer coils next to line as a charging wave for the potentials of the transformer terminals is abruptly reduced. Since the inner layers can not get rid of their charge immediately there is a momentary potential across the coils between a high-potential point in the inner layers and a low-potential point at the terminal.

(*b*) Grounds—Grounds are also a cause of abrupt change of potential and short-circuits. The same strain on coils is produced as before, strongest on the side of the circuit where the ground occurs; also the ungrounded lines are raised to full potential above the earth. It is true that the rise of potential of the ungrounded lines is not necessarily as abrupt, since it is produced partly by the generator.

It must be remembered that the static waves produced in lines by grounds and short-circuits may have their intensity doubled at a reflecting point, so that the short-circuit strain on coils is doubly severe at such points. However, the strains to ground are not great in these cases except on the ungrounded wires.

It must be remembered that when a wave is caused by grounding or charging a line that the abrupt change of potential may sometimes be only the voltage existing between line and ground in that system and not the full line voltage.

In much of the previous discussion, transmission lines have been assumed to be single-phase. The conclusions arrived at are nearly all applicable to polyphase lines as well, with occasional changes which will be evident on inspection.

(*c*) Lightning—Lightning is the best known case of static disturbances. Unlike neutral grounds, short-circuits and switching, lightning usually does not act directly on the circuit but indirectly by induction. Its effects, however, are of the same nature as those already discussed.

In general lightning may affect a transmission line in two ways; by induction and by direct stroke.

(1) A lightning discharge in the neighborhood of an electric circuit but not actually reaching the circuit acts upon it indirectly by a combination of static and dynamic induction. The actual intensity of the effect in the circuit depends on the energy of the lightning discharge, on the distance to the circuit, its form and its position relative to the discharge path of the lightning and upon other conditions.

Lightning discharges are usually of an oscillating nature, that is, the charge on the cloud oscillates backward and forward between cloud and earth several times, pausing at each end of its path in each oscillation. This oscillating charge acts inductively on any electric circuit which is in the neighborhood, first (static induction), when pausing at either end of its path (by attracting a charge of the opposite sign to the nearest point of the circuit) and second (electromagnetic induction), since the actual discharge is a current and sets up an opposing electro-motive force in any parallel conductor. As the lightning charge appears first at one end and then the other of its discharge path it draws the charge on the line back and forth and the electro-motive force in the line induced by the current in the discharge is always in such a direction as to accelerate the motion of the attracted charge. Therefore the effect of the lightning discharge is to cause a static wave or a series of static waves in the line. These waves are similar in general character to those produced by switching, etc., except that there is no limit to their maximum possible strength. They may produce either grounds on windings or short-circuits in coils as circumstances may determine. The static strains produced in a circuit by lightning have no direct relation to the generator voltage but are determined by the form and location of the line, the protective devices, and the nature of the lightning discharge.

(2) A lightning discharge may and occasionally does strike a line directly. In this case it is commonly supposed that nothing can save the apparatus from injury. This may or may not be the fact according to circumstances. If the discharge strikes the line at some distance from the apparatus, there is a very good chance that no harm may be done, for the choking effect of the line is enormous for the extremely abrupt discharge of a direct stroke. That is the discharge can not pass down a long line quickly and instead will pile up voltage at the point where the line is struck and finally make some direct path to earth, usually by jumping to a pole. This relieves the line and no severe shock is sent to the station. The escaping discharge may or may not destroy the pole according to the nature of the pole and the intensity of the discharge. But although the chief discharge passes to earth directly there will be a wave sent along the line, which may or may not do damage according to circumstances; thus in this case the arresters are not required to discharge the direct stroke. On the other hand, if the stroke is near the apparatus it is probable that protection will not be obtained from any lightning arrester. Even though the arrester were, for the moment, a direct connection between line and ground there would be sufficient resistance and inductance in the ground connection and the discharge path in the earth itself, to prevent an absolutely free discharge and the result would be that the lightning would find other paths to the ground. The case of a direct stroke by lightning near a station very rarely occurs.

(*d*) Paralleling out of Phase—One more case of static may be mentioned. When two lines are thrown in parallel out of step there is an abrupt change of potential produced when the second leg of the paralleling switch is closed. This voltage change may run up to double line voltage if the generators are directly opposite in phase. The same effects may be produced when two generators are running in parallel by opening all the poles of the paralleling-switch except one, for the machines soon get out of step. In this case a synchronous motor or rotary converter will act as a generator for a time long enough to cause any possible damage to be accomplished.

The most frequent causes of dangerous static disturbances in high-tension circuits have been discussed. It is evident, however, that anything which causes an abrupt change of static potential of considerable severity may cause a dangerous strain on apparatus. In actual experience as a result of such strains short-circuits in coils are more common than grounds on windings.

Resonance—Resonance does not strictly speaking come under the head of "static," but to show its relation to the actions already discussed, some attention will be given it. As already frequently stated any condenser discharging through inductance (the resistance being small) has an oscillating discharge as a pendulum has an oscillating motion. If now an alternating electro-motive force be applied to the discharging condenser in such a way that the electro-motive force alternates just as often as the condenser discharges and is always in the same direction as this discharge, the intensity of the oscillations will get greater and greater, just as the vibrations of the pendulum will get greater and greater if an alternating force is applied to it in such a way as always to increase its swing. There is no limit, theoretically, to the voltage that may be reached after a sufficient number of oscillations if there are no losses. However, in an actual trial the loss of energy in resistance and elsewhere gets greater as the oscillations get greater and will finally equal the energy put in by the alternating elec-

tro-motive force and thus stop the increase of voltage. Also, the exciting electro-motive force may slowly get out of step and so after building up the oscillations for a while reduce them again. The increase of voltage may be stopped by a breakdown of insulation which may occur on account of the high voltage. That is, if we have an oscillating circuit (as, for example, a short transmission line) and an exciting cause of exactly the right alternations, a very high voltage may result. The exciting cause may be either the generator electro-motive force or it may be some static electro-motive force; for example, another discharging condenser. In very few cases in actual installations, however, has it been directly shown that resonance has caused any serious rise of potential. There is no justification for hastily assigning resonance as the cause for unexplained static phenomena.

The number of complete oscillations per second in a circuit consisting of a choke coil and condenser $= 1/2\pi\sqrt{LC}$. So for the circuit to have a frequency of 7,200 alternations would require that the product of its capacity and inductance shall equal $1/(2\pi 60)^2$. If the capacity equals ten microfarads the inductance must equal seven-tenths henry, which is a large value. This shows that resonance with the generator electro-motive force is very unlikely in high-tension lines. A condenser of one-tenth microfarad with a coil of one-one-thousandth of a henry has 16,000 complete oscillations per second.

When an alternating electro-motive force is applied to a long transmission line, however, the action is somewhat different from that of a simple condenser. The first alternation of the electro-motive force sends down the line which is reflected back if the end is open. If the applied electro-motive force is just slow enough so that as it starts on its negative swing the reflected wave is just beginning to arrive again at the starting point its electro-motive force is added to that of the impressed voltage, and a second wave of double strength is sent along the line—when the next alternation is reflected back the applied electro-motive force has reversed and again adds to the amplitude of the wave—thus just as with a condenser an excessive voltage will be built up if there are no losses. But suppose that the generator has three times this frequency. The applied electro-motive force will then have the same relative value, when the first wave reaches the beginning of the line, after reflection, as when it has only one-third the frequency, though two other waves have been sent into the line. The amplitude of the first wave will then be doubled as before and the same with the two succeeding waves. But by this time the first augmented wave has again been reflected and reached the starting point so that it has a further increase of amplitude. The same thing occurs if the applied electro-motive force has its frequency increased to five times its original value, only five waves are operated on at once instead of three as in the previous case; similarly with 7,9, etc., times the original frequency (which was such that in the time of one alternation a wave would pass the length of the line and return). Resonance of this type with a long line is much more likely to be met than with a simple condenser, for there are a great number of frequencies at which resonance may occur.

If the periodicity of the applied electro-motive force is not exactly right for resonance (this applies to long and short lines) there will still be a certain amount of rise of potential which will be less as the electro-motive force departs further from the proper frequency.

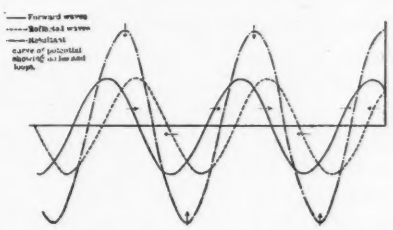


FIG. 6.—NODES AND LOOPS IN A LONG LINE OR CABLE.

A summary of the conclusions so far reached follows:

(1) When a "dead" transformer is connected to a live line a strain may be produced on the layers of the coil next to the terminal which may be as great as the line voltage.

(2) When a short line is charged suddenly from live bus-bars, a momentary voltage rise may be produced which will be not more than double voltage.

(3) When a long line is charged a strain similar to that in the short line is produced, doubling the potential first at the end of the line and afterward along the whole length. This result assumes that the terminal of the line is abruptly raised to full normal potential and rigidly maintained there until the wave is fully formed; also that the losses are zero.

(4) The fundamental principles governing the charging of a cable are the same as those of a transmission line.

(5) Opening a light high-tension circuit is nearly the equivalent of charging the circuit since before the line is completely freed from the bus-bars it is often momentarily recharged several times.

(6) When a branch line of small e. s. capacity is supplied from a main line, the rise of potential at the farther end may be twice as great as at the end of the main line.

(7) In addition to switching, other causes of static strains are grounding, short-circuit, lightning, etc., when these cause abrupt changes of potential.

(8) A rise of potential due to resonance is always possible, but generally improbable. It requires that there be an oscillating circuit and an exciting cause which must be of very nearly the same frequency as the oscillating circuit. When an alternating electro-motive force of high frequency is applied to a long line the danger that resonance will occur is usually greater.

PART II—PROTECTION OF APPARATUS AND THE STATIC INTERRUPTER.

TRACING OF DAMAGE DONE BY STATIC.

From the discussion in the first part of this paper, the conclusion seems warranted that some sort of static protection for apparatus in high-tension circuits is very desirable. This fact has, indeed, long been almost universally recognized in a partial way, as is shown by the wide use of the lightning arrester. But the lightning arrester as commonly found falls far short of affording complete protection, although it has, in fact, been quite effective in preventing grounds in apparatus (its only avowed object). As every person familiar with the operation of high-tension electric apparatus knows, short-circuits as distinguished from grounds are a much more frequent cause of difficulty than grounds proper. Now, lightning arresters have little effectiveness for preventing short-circuits, since the short-circuit, when caused by static, is usually the result of the concentration on a small portion of the coil of a voltage, not necessarily great with respect to the line voltage, but perhaps very great with respect to the normal voltage of the portion of the coil where the failure occurs. Some protection, however, has often been secured by the use of choke coils in addition to the lightning arresters; but these have often been used in an aimless way, and have sometimes been omitted in very high-tension circuits, where they are the most necessary.

The chief reason why static protection has not received more careful consideration (although the lightning arrester proper has long been in commercial use) is the very great difficulty of tracing the

effects of static to their true causes. In the first place very little is generally known as to what causes static strains and as to whereabouts in the circuit they are to be expected, nor as to what sort of injuries they inflict. The direct damage from an excessive static strain is usually limited to the injury that can be caused by a spark carrying nothing but charging current to some small portion of the apparatus. Such an injury would be invisible to the eye. A great many repetitions would be required before an evident defect would appear.

In the second place, when trouble develops from a static cause it is usually made manifest by an arc supported directly by the generator. This arc, of course, causes a great amount of burning of insulation and fusing of copper, which destroy all evidence of the original cause of the failure. Also at such a time usually little note is taken of attendant circumstances which could throw some light on the cause of the trouble. Most engineers will appreciate the great difficulty of getting afterward the exact sequence of events in any breakdown. Again, sometimes a severe static strain will select some particular point where some defect in materials or workmanship exists, and this imperfection, when found, is assigned as the cause of the failure, even though the defective part may have been amply able to withstand normal potential.

Still another fact renders the tracing of static strains difficult. Only occasionally are the conditions favorable for the exciting spark to be followed by the normal electro-motive force of the circuit, which alone makes the spark detectable. That means that if a watch is kept for the effect of any particular cause of static, such as switching, perhaps nine times out of ten this effect will not be discovered, because it is not made evident by the generator electro-motive force.

Sometimes a short-circuit may be started by a static spark which involves a few turns of the coil or has so much resistance that the fuses and instruments will not be noticeably affected, and nothing is known of the trouble until it has developed, which may require some minutes or some hours.

I do not mean to give the impression here that I consider every failure of high-tension apparatus to be, somehow or other, due to static causes, for such is far from the truth; nor that such difficulties are of every-day occurrence, for this would be much further from the truth; but it is true that static strains do cause breakdowns, and that such are very difficult to trace to their true causes.

PROTECTION FROM STATIC.

Protection from static is a question of growing importance, for several reasons. Circuits of high potential and long distances are rapidly extending, both as regards number, size and potential. The troubles due to static are certain to be more commonly recognized. In the future the standard of service will gradually rise and nothing threatening its interruption will be tolerated.

I propose, in what follows, to describe the system of protection of high-tension apparatus from static strains that is applicable to practically all cases of high-tension transmission. In actual plants difficulties from static are found to occur usually in generators, transformers or instruments connected directly to the high-tension circuits, or between lines, or to ground at ends of lines or other reflecting points. Direct strokes of lightning are an exception to the statement regarding the location of damages. Why strains should appear at these points has been already explained.

These injuries are of two distinct classes, short-circuits and grounds, each type of injury being caused in a different way and requiring its own protective apparatus. They will be treated separately.

PROTECTION AGAINST SHORT-CIRCUITS.

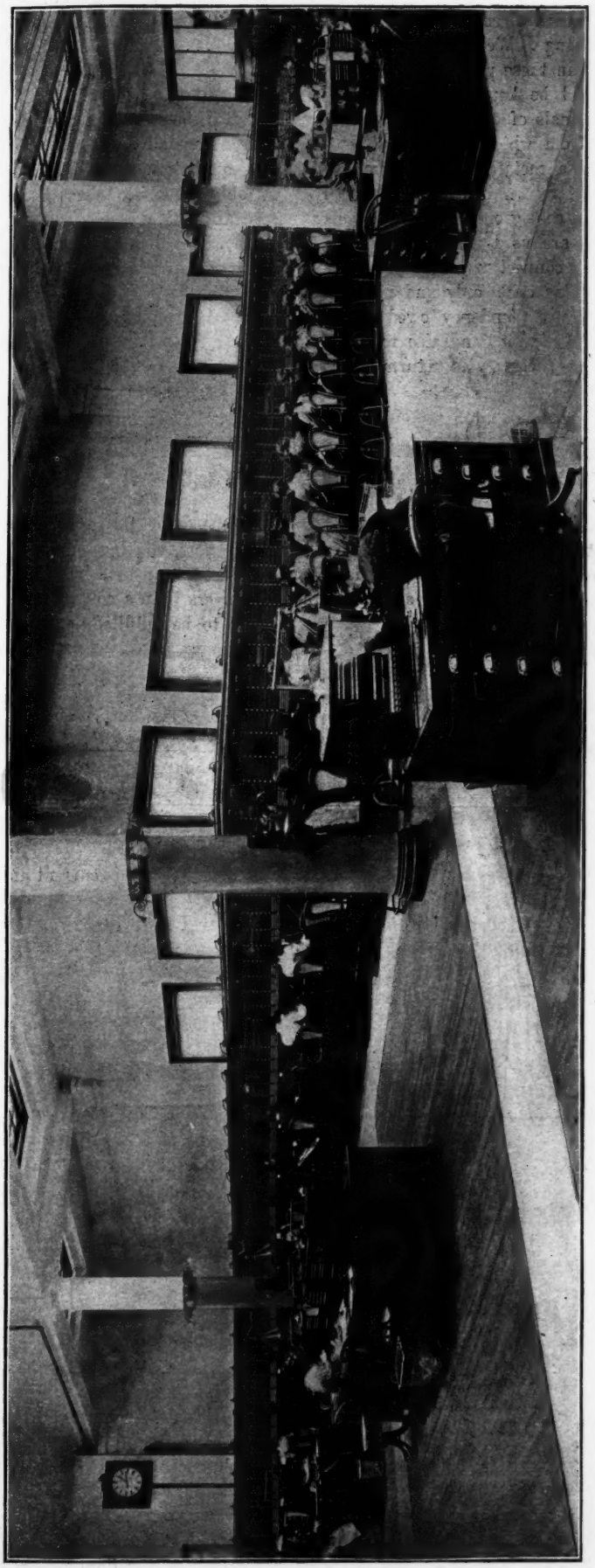
As already fully explained, static causes short-circuits by producing a momentary concentration of potential (which may or may not be greater than normal line potential) upon a few layers of the coils, which very probably may have been intended to withstand only a small part of the strain brought upon them. This successive momentary strain results from a very abrupt change of potential of the terminal or other point of the coil, either up or down. With such a change, until charge can flow to the more distant layers, the full voltage of the potential change will be impressed on the layers of the coil between the point of application of strain and those points to which charge has not penetrated. If this voltage is too much for the strength of the insulation a spark passes. If conditions are favorable the electro-motive force of the generator causes a current to follow, and a burnout will usually result. In some cases, however, current from the generator may start to follow and drop out at the end of the first alternation.

The characteristic of the static wave which causes the static strain to be concentrated on a few layers of the coil is its abruptness. Therefore, if this wave be forced to pass through a choke coil and its abruptness thus reduced, the strain on the coil would be lessened; if the choke coil be sufficiently powerful the wave will be rendered harmless. It must be noted that it is by no means necessary for the choke coil to be effective, that it be made powerful enough to entirely remove the strain from the transformer coil, for its insulation will withstand a much higher electro-motive force of a static nature which exists but an instant than of a continuous nature like that impressed by the generator. Also, there is usually allowed (perhaps on account of the results of previous experience with static) a very great margin in the insulation between the layers of coils.

The exact amount of abruptness allowable in the wave will depend on circumstances. Looking at the question more closely it is seen that a choke coil can not be said to have a definite protective power regardless of the apparatus it protects. For more choking effect is required to protect a transformer coil of many turns or layers than a coil of few. The condition to be fulfilled is that by the time maximum voltage is reached at the transformer terminal, charging current shall have penetrated far enough into the transformer coil so that a sufficient number of layers shall share the strain for the combined insulation strength to be able to resist it. The function of the choke coil is thus seen to be simply one of delaying the wave to give the inflowing charge time to become distributed over the coil. The length of time required depends on the rate at which the charge penetrates the coil and the strength of the insulation. It has already been stated that the rate at which the wave penetrates is inversely proportional to the square root of the product of its e. s. capacity and its inductance. The inductance of the protecting choke coil should be larger than that of the minimum portion of the transformer coil which is able to stand the strain of the most severe static wave that may occur.

But such a choke coil has other effects than the retarding of static waves, it will also retard the normal flow of current; in some cases to such an extent as to be quite an undesirable feature. The choke coil also has resistance and will waste energy, and unless a prohibitive cost of copper is used this loss of energy will sensibly affect the efficiency of the plant; further, the coil will get too hot. It will be found in most cases that with high-tension apparatus choke coils powerful enough to protect perfectly are impracticable on account of size or cost.

(Concluded next week.)



"MAIN" OPERATING ROOM OF THE NEW YORK & NEW JERSEY TELEPHONE COMPANY, BROOKLYN, N. Y.

Brooklyn's Big Telephone Exchange.

The "Main" exchange of the New York & New Jersey Telephone Company occupies the whole of a large building at No. 81 Willoughby street, Brooklyn, N. Y. This exchange exemplifies the highest type of a common-battery system and was opened for business on November 13, 1900.

Throughout the city the lines of this company thread their way underground in tile conduits, entering the basement of the company's building in a compact series of lead-covered cables. Here they are met by the first side of the main distributing board and are connected across to the secondary side where they are placed in systematic numerical arrangement. There are nearly 4,000 circuits connected up on this board at present, the ultimate capacity being some 6,000 lines. From the main distributing board in the basement the cables are conveyed to the top floor where is situated the intermediate distributing board. One branch of the lines go direct from the intermediate board, and another is connected through relays to the lighting signals on the switchboard in the main operating room. In this room have been consummated the greatest additions to the company's system. Since the photograph which we show was taken other sections of boards have been added on the left, making a curve, so that now an almost complete ellipse of switchboards has been formed.

The positions on this switchboard are laid out according to classes of service of which there are three, *viz.*, flat rate, message rate and pay station. A large toll-board, with a capacity for accommodating thirty-three operators, has been installed in this room, and all the main trunk lines from Long Island points and the principal points in New Jersey are handled here.

On the same floor as the operating room and adjacent to the intermediate boards is situated another switchboard for controlling the generators and other dynamo machinery. In this section of the room is the power supply which comes from large accumulator cells, supplied by motor-generators working on one side at 125 volts and giving on the other side about twenty-five. The generators for the ringing service are also placed in this section. All of these machines are in duplicate, and to further obviate any loss of time due to breakdown, connection can be had immediately in case of emergency with the electric supply from the light company outside.

A constant expansion of business is taking place, there now being about 43,000 stations in this system. The present officers are: Charles F. Cutler, president; W. D. Sargent, vice-president; Waldron Hoppins, secretary; Henry Sanger Snow, treasurer; John C. Reilly, general manager.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XXVIII.

BY A. E. DOBBS.

Almost every one connected in any way with the telephone business is more or less familiar with the ordinary subscribers' circuit from the telephone through the drop and jack which is here reproduced as Fig. 109, but not many have studied out the possible effect of the arrangement of certain appliances upon the service

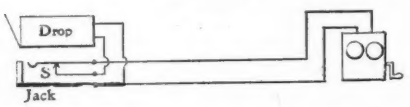


FIG. 109.—SUBSCRIBER'S LINE AND CIRCUIT.

rendered, and for the present we will indulge in a study of drops and their possible effects upon each other in regard to the trouble known as cross-talk.

Cross-talk may proceed from several causes, the first and most likely of which is poor insulation of the cables, cords or jacks which allows a leakage of current from one line into another.

The second may come from electrostatic induction which we have already discussed in chapter xviii on the transposition of lines. It might come from lines inside as well as out and is worse the more the lines are "bunched."

The third might come from electromagnetic induction, as, for example, the straying of the magnetic lines of force from one drop coil into an adjacent one, or the noisy effect produced by the presence of a heavy battery or other strong current in closely parallel conductors.

CURRENT LEAKAGE.

If the leakage from one line to another is caused by poor insulation of the cables, then the remedy lies in overhauling the cables. A great deal of this trouble is due to the use of cotton-wound annunciator wire around the racks and switchboard, the remedy for which is to substitute silk-wound wire, though the trouble might be helped by boiling out the cotton cables (pouring hot paraffin over them till all bubbles disappear) and afterward covering them with a pure alcohol shellac to prevent the paraffin absorbing more moisture.

There is another and very common cause of leakage that comes from the use of a common return wire instead of metallic circuits, the remedy for which is properly proportioned return wires and metallic circuit switchboards.

As to the latter nearly all manufacturers build their switchboards as though intended for complete metallic circuits, leaving the responsibility for grounded or common return circuits upon the owner of the exchange. We have also previously mentioned in these papers that these circuits should be kept metallic until the outer terminals of the cables are reached at least, from which place lines can be made into a metallic circuit, grounded, or common return lines, as may be required. In case grounded or common return lines are used the common return wire should connect with the lines in that one particular cable only and no others, which will have a tendency to reduce cross-talk to a minimum, and also reduce the size of wire necessary to return the current to the cable terminals. Another good plan in arranging a system of this kind is to so balance the ringer and drop coils that the resistance of lines in use and lines not in use will be approximately equal to each other. For example, we will suppose the lines in use to have a resistance of 350 ohms divided as follows:

Induction coil	225 ohms
Receiver	75 "
Line	50 "
Total	350 ohms

To use this we would have for the lines not in use

Drop coil	200 ohms
Ringer coil	100 "
Line	50 "
Total	350 ohms

As will be seen by a glance at Fig. 110 the lines are all connected together by the common return wire so that the current not only comes back over the return wire, but also divides itself over all the other lines in proportion to the resistance encountered, and the problem is to so balance these resistances that a very small portion only will pass over the other lines, especially those in use. The advantage of high-resistance coils lies in the fact that

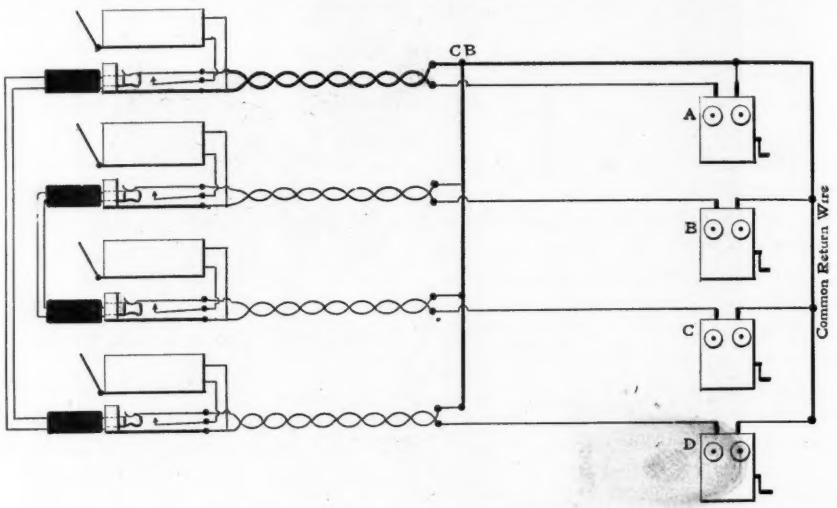


FIG. 110.—COMMON RETURN (MCCLUER) SYSTEM.

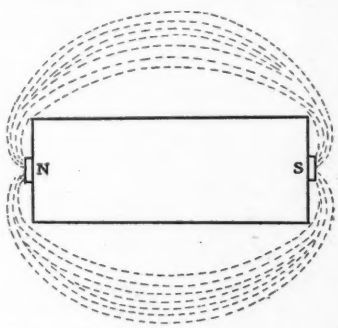


FIG. 111.—MAGNETIZED COIL AND LINES OF FORCE.

they will divide this current and make all the lines so nearly equal that a difference of twenty-five or thirty ohms between lines will still not affect the general result of our calculation. It may be taken as a self-evident proposition that if we could keep all of the return current on the return wire we would get no cross-talk, except such as might come from static induction, especially if our return wire ended at the outside cable box, for once connected to a paired cable the cross-talk will take care of itself.

In the first place we will suppose the resistance (average) of all the lines given above to be 350 ohms, that there are 100 lines leading from the cable pole and that the return wire is not connected to the box but cut off at the point CB, the "ground" side of all lines being connected together in the box. In this case all the lines are connected together and act as carriers for the return current back to the switchboard. In this case we have $\frac{350 \text{ ohms}}{100 \text{ lines}} = 3.5$ ohms as the total resistance of our circuit over the other lines.

This 3.5 ohms in this case then represents 0.01 of the total return current or

one per cent as the share each line will return to the drops on the switchboard, which leakage, small as it is, would be audible to any one who might be listening at his receiver.

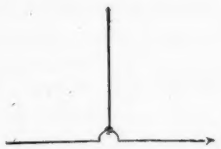


FIG. 112.—EXPLORING NEEDLE.

With our common return wires connected to the box the current is then divided, half passing over the return wire and half passing over the other lines, or 0.5 of one per cent as the share each line receives which could still probably be heard, though faintly.

As will be seen the fifty ohms allowed above the line resistance between the cable and subscribers' instruments means about three-fourths of a mile, if No. 14 BB iron wire is used and, therefore, a copper return wire would have to be of a size to not have a resistance factor exceeding 1.67 ohms to the mile, which corresponds to about No. 9 B. & S. gauge. This is only a simple demonstration and leaves out of consideration the lines in use and the lines not in use, but it may be remembered that the lines when connected

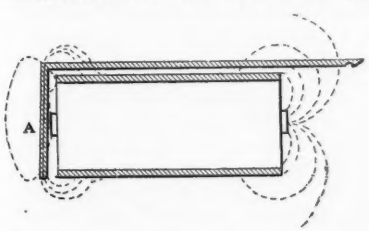


FIG. 115.—INCORRECT MAGNETIC SHIELDING.

together double their resistance, which cuts their leakage from one to the other to one-fourth of one per cent instead of one-half of one per cent which is the case when a subscriber rings in. In addition, if the drops on the board are armored or encased in an iron shield, as is done by a great many manufacturers, the impedance of the drop confines a still larger portion

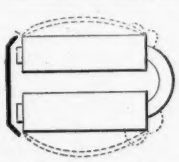


FIG. 118.—DOUBLE MAGNETS.

to the return wire. Our formula therefore becomes $RW = \frac{R}{N}$, in which RW is the resistance of the return wire, R the average resistance of the lines to the centre of distribution and N the number of lines connected to the return wire. It might be supposed that the use of a larger return wire would reduce this still more, and so it would, but not in proportion to the supposed benefits to be derived.

Thus suppose in the above example we were to cut down the resistance of our return wire to 1.75 ohms or just half that of the No. 9 wire given above. To accomplish this we would have to double the weight of copper used and only gain one-

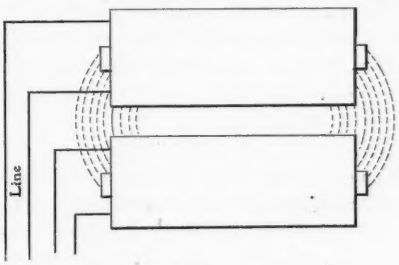


FIG. 113.—STRAYING LINES.

third of one per cent, for our ratio would now stand

Lines ..... 0.33 of one per cent
Return wire.... 0.66 of one per cent

From this it will be seen that we have doubled the weight of copper and gained little.

We might gain something by the use of a No. 3 wire which doubles the weight again in which case we would now have

Lines ..... 0.0025 per cent
Return wire..... 0.0075 per cent

Equivalent to a gain of 0.5 of one per cent. At nineteen cents a pound we have increased the cost of the return wire from $39.52 in the case of No. 9 to $158.08 in the No. 3 and gained one-half of one per cent.

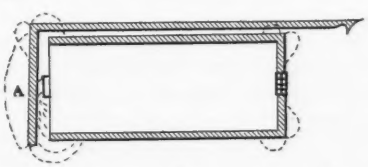


FIG. 116.—CORRECT MAGNETIC SHIELDING.

Suppose we double again which brings us to No. 0 wire which leaves us with

Lines ..... 0.00125 per cent
Return wire..... 0.00875 per cent

Or one-eighth of one per cent for the lines, seven-eighths of one per cent for the return.

This, of course, is a distinct gain, but the cost of the return has risen to $316. Does it pay?

The return wire should be maintained at its full size till the centre of distribution has been passed, for if, as in the above case, the lines will average three-fourths of a mile in length, the return wire, whether No. 9 or No. 0, should be carried at least a mile from the box, and not till at least three-fourths of the telephones have dropped off should the size be reduced, for by keeping up the size of the return wire you ensure an equal division of current to all the lines between the long and short ones.

The more current you can return on the return wire and the less on the other lines the less the trouble from static induction, a fruitful source of cross-talk. Tolerate no bad connections in the return wire.

MAGNETIC LEAKAGE.

There is another class of leakage caused

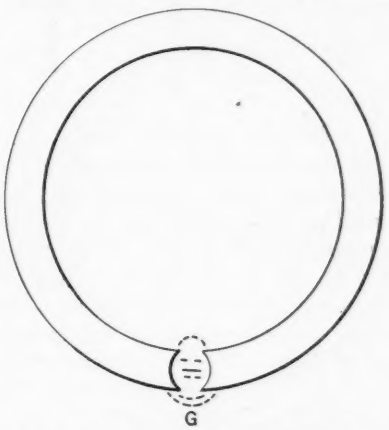


FIG. 114.—A CORE WITH NO EXTERNAL MAGNETISM.

by magnetic induction from one coil to another, for it is a well-known fact that an electrical disturbance in one coil has a tendency to set up a like disturbance in any other coils or conductors that may be in the immediate vicinity, for the lines of force that agitate the core of a magnet must return around the outside, for like electricity magnetism must have a closed circuit, and the only way we can get work out of a magnet is by opening this magnetic circuit and placing an armature in its path.

In Fig. 111 we have a magnetized coil, around which the lines of force, represented by dotted lines, are shown. One

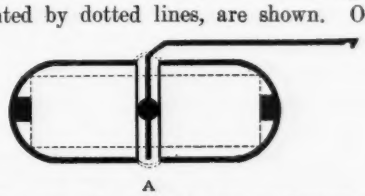


FIG. 117.—NO CORNERS AND NO STRAYING LINES OF FORCE.

end of this coil is a north (N) and the other a south pole (S). Now, whenever a current passes over a wire, whether hung in the air or wound in the form of a coil, lines of force are set up in the immediate vicinity at right angles to the wire. When wound in the form of a coil these lines pass out at the north pole and return again

to the south end, some passing through the centre and some around the outside, which can be proved by a very simple test by the use of a piece of iron or magnetized steel wire suspended by a thread (Fig. 112) so that it can turn or dip in any direction, and by the use of which we can easily map out these lines.

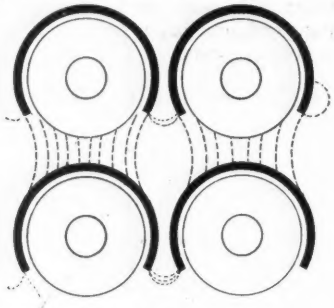


FIG. 119.—A PARTIAL SHIELD.

An iron core in the centre of the coil (Fig. 111) seems to attract the lines toward the centre, which it is the intention of magnet-makers to attain to the greatest possible extent, for the more lines attracted to the core the greater its power, but for all that we find that a large number of them still pass over the outside. Where there are several magnets set close together these lines may, and do, seek a path through other coils which, in a telephone circuit, may become a serious source of cross-talk, as shown in Fig. 113.

An ideal form of magnet is a closed ring, but unfortunately, except in the case of a transformer, we can get no work out of it, so we make a short gap in it, as in Fig. 114, place our armature in the gap we get very little stray magnetism and the greatest possible amount of work, and this is the form adopted in volt and ammeter construction.

But this form is not adapted to switchboard work, and possibly the next best form would be found in Fig. 118 in which the poles of the magnet are set close together with a curved armature covering them, but even in this form we find external magnetism, and besides it is a form not adapted to switchboard work where space is valuable.

In order to prevent these lines from straying into other drops, the form shown in Fig. 115 is sometimes used, which consists of a tube of soft iron slipped over the coil but open at both ends. This form decreases the pulling power of the core to a certain extent by drawing away many of the lines from the centre, but still there is more stray magnetism at the ends than there should be, which brings us to Fig. 116.

This is a coil completely enclosed, one end being completely covered with the iron shield which is attached to the core, while the other is covered by the armature which really makes it a double-pole magnet, the end of the core next the armature A being one pole, and the end of the shield under the armature being the other. There is a little stray magnetism at the corners, for like static electricity magnetism escapes at sharp points, or corners, but there is so little and the coils being all enclosed no disturbing effect is observed.

Fig. 117 is, theoretically, a more perfect form, as there are no sharp corners anywhere, and the armature swings between two poles that meet near the middle or neutral part of the coil.

Practically it is probable that the difference between Figs. 116 and 117 could not be detected to any appreciable extent.

All tubular magnets by diverting lines of force from the core and adding the

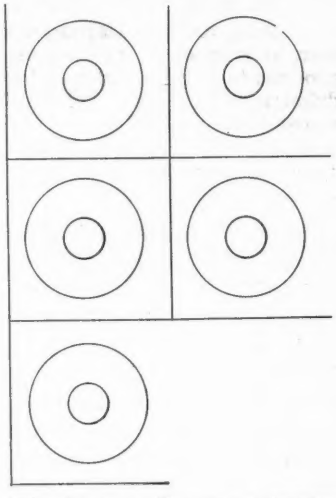


FIG. 120.—ANOTHER METHOD OF SHIELDING DROP.

retarding effect of the iron tend to make a drop sluggish and less sensitive, so that a 500-ohm coil armored has the retardation of 1,200 ohms unarmored.

Previous to the expiration of the patent on tubular magnets one manufacturer adopted a shield that covered about two-thirds of the magnet, as well as the ends.

Fig. 119 shows a group of these magnets and the lines of force surrounding them, but it will be seen that the lines straying from the open side of one coil are caught by the shield below it. While very effective, this form was not entirely satisfactory, and it has since been changed to the form shown in Fig. 116.

Another manufacturer surrounded his coils in a half case of brass, and, as will be seen in Fig. 120, each coil was in this way surrounded by a metal case. While this undoubtedly reduced the tendency to cross-talk, yet brass will not shield magnetic lines altogether.

Nearly all manufacturers of good standing now surround their clearing-out drop coils in the cord circuit with an iron shield like Fig. 116; the drop, however, being open on one side is supposed to be out of circuit altogether and generally left unarmored, but it is not certain that such is the case, for we know that in the

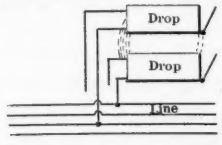


FIG. 121.—A POSSIBILITY OF STATIC INDUCTION.

case of wireless telegraphy a conductor run up into the air will convey static effects for as much as 200 miles. Therefore, it does not seem impossible that two drop coils placed close together, as in Fig. 121, may convey a static effect from one to the other. Some manufacturers, in order to take no chances on this, armor their drops as well as the clearing-out coils.

Why would it not be just as well to avoid this expense, however, by adopting a jack like that shown in Fig. 122, which would remove all cause of suspicion by cutting out both legs of the drop circuit?

Engineering Trade with Japan.

An interesting statement by Mr. J. H. Longford, British Consul at Nagasaki, was made at the last monthly dinner of the London Chamber of Commerce. In directing attention to the important advance of Japanese trade, he expressed the belief that there will be for many years to come a steadily growing market for machinery of every description, especially in spinning, weaving, printing, sugar refining, electrical apparatus of all kinds, locomotives and railway appliances, boilers, bridges, fire engines, pumps, and

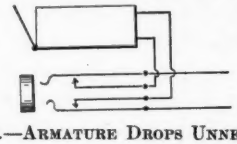


FIG. 122.—ARMATURE DROPS UNNECESSARY.

arms and munitions of war. "As Mr. Longford speaks from experience extending over many years, to which testimony was borne by the minister plenipotentiary of Japan, his advice deserves the careful attention, says the *Mechanical World*, of British firms engaged in the export trade to that country. We are glad to learn the Consul does not consider that British manufacturers need view with any extravagant alarm the competition of Germany, either in China or Japan; but he warns them to take into account the gravity of the rivalry of the United States. Unless a radical change is made in British methods, he is not so sanguine that we shall hold our own commercially with America in the far east, as we may hope to do with Germany in that part of the world."

Independent Telephone Association of Wisconsin.

Third Annual Convention of This Association at Milwaukee.

THE third annual convention of the independent telephone companies of Wisconsin was held at Milwaukee, February 19 and 20, 1902. The meeting was called to order by President A. L. Hutchinson in the convention hall of the Pfister Hotel.

The president read his annual address, giving the statistics of the independent telephone companies in the state, showing the rapid progress being made and that better construction was being generally used. He discussed at length the contract for connecting which the Bell telephone company is offering the independents, and advised strongly against any affiliation with the Bell company.

The independent telephone exchanges of Wisconsin have some 25,000 subscribers and 175 exchanges, and over 800 toll stations. The amount of capital stock invested is about $3,000,000. During the past year half a million was expended in construction.

Mr. E. R. Conklin, of the Interstate Telephone and Telegraph Company, of Joliet, Ill., by request spoke on the telephone condition in his state, and warned all companies against entertaining the proposition of the Bell company: the duty to subscribers and stockholders forbids it. The exchange and local toll line business having been developed by the independents, they are now in a position to build their own copper trunk lines.

Mr. Cummings, of Wasseca, Minn., made a short address on telephone conditions in that state. The meeting then adjourned until two P. M.

The meeting reconvened at two P. M., and the Hon. J. A. Gaynor, of Grand Rapids, read a paper on "Disadvantages of Connecting with the Bell Company."

Dr. I. A. Lumpkins, president of the Illinois association, then addressed the convention and took a strong stand against affiliating with the Bell company. He urged the formation of an interstate telephone association to embrace the independents within a radius of 500 miles of Chicago. He stated that the telephone business was still in its infancy and that its possibilities were unlimited.

Mr. J. J. Nate, of the Stromberg-Carlson Telephone Manufacturing Company, Chicago; Mr. S. A. Dinsmore, of the Electric Appliance Company, Chicago, and Mr. McMeal, of *Telephony*, spoke in favor of attending the convention and forming such an association, and upon motion the invitation was accepted.

Mr. G. D. Jones, of Wausau, then opened the discussion of Mr. Gaynor's paper. He pointed out the disadvantages the independents were now under for lack of long-distance trunk lines and stated that such lines must be built if the local companies are to be kept from connecting with the Bell company. The paper was then generally discussed by Messrs. Gaynor, Bell, Valentine, Slater, Harper, Baer, Crowley and Ferdinand, all taking a strong stand against entertaining any Bell proposition.

It was then moved and adopted that a committee of five, consisting of Mr. Jones as chairman, and Mr. Gaynor, with three others to be appointed by the president, be appointed to consider and report upon the advisability of any independent telephone company accepting any proposition for connection from the Bell telephone company, and that such committee make a report the next morning. The meeting then adjourned to nine o'clock the next morning.

SECOND DAY'S SESSION.

The convention reconvened at nine o'clock, and Mr. F. S. Veeder presented the report of the committee on combination rates and their division, as follows: "Such combination toll to be two-thirds of the local toll rates and be divided on a basis of one-half of the sum of air-line and pole-line distance between entering and outgoing stations of the companies transmitting such messages, figuring each message as equal to three miles of line."

Before the report was acted upon, Mr. E. B. Fisher, secretary of the Citizens' Telephone Company, of Grand Rapids, Mich., was requested to deliver his address on "Possibility of Association Effort." He told of the growth and present telephone conditions in Michigan. The basis of toll-line rate in Michigan is one-half cent per mile of air-line distance for a five-minute talk, and the zone system is used for estimating toll rates. Exchanges get twenty-five per cent of the outgoing business; toll stations fifteen per cent. He stated the great benefit gained by associated effort and said he would rather see numerous local companies than one large state company. He pointed out the valuable work accomplished by the National association, especially in fighting the telephone patent litigation, and spoke of its recent victory in the bridging bell suit. He spoke strongly against listening to the overtures made by the Bell company. Associated effort would aid in securing franchises in large cities.

Mr. Jones, chairman of the committee to consider the Bell proposition for connection, presented the report of his committee, which stated: "We believe that it is against good public policy, therefore, to enter into any contract that will limit the use of the telephone service to the instruments of any one make, or that will make discrimination against any properly constructed toll line or telephone exchange."

On motion the report was unanimously adopted.

Mr. James B. Keelyn, of the Keelyn Manufacturing Company, Chicago, then made an address on the "Relation of the Manufacturer to the Operator," saying that their interests are identical; that there should be a close relation, and advising against entering into contracts with the Bell company or substituting its instruments for the ones now used. He considered most instruments now being used by the independents superior to the Bell apparatus. The adoption of the Bell transmitter and receiver would lead to the adoption of other Bell apparatus. He also spoke of the inadvisability and practical impossibility of standardizing telephone apparatus. The manufacturer had been true to the support of the operator, then the operator should likewise be true to the interests of the manufacturer.

Mr. R. G. Abbott, of the John A. Roebling's Sons Company, read a paper on "Telephone Cables and Their Construction." He discussed the various gauges and kinds of insulation and enumerated the advantages and disadvantages caused by the various kinds used.

Mr. C. W. Farr, president of the Farr Telephone and Construction Supply Company, read a paper on "Bridging Magneto Bells," discussing the main requirement that a good magneto bell must meet. The paper was discussed by Messrs. Slater and Keelyn. On motion the meeting was adjourned to 2.30 P. M.

The session reconvened at 2.30 P. M., and the secretary read the invitation of Mr. I. P. Lord, of Waupaca, to hold the summer meeting of the association at Waupaca in conjunction with that of the Northwestern Electrical Association, which is to meet there on June 26, 27 and 28. The invitation was accepted.

It was also moved and adopted that the Independent Telephone Association of Wisconsin endorse the invitation of the city of Milwaukee to the National Telephone Association to hold its next meeting in Milwaukee. On motion it was decided to hold the next annual convention of the association at Milwaukee.

The convention then elected officers for the ensuing year as follows: President, Richard Valentine, Janesville; vice-president, H. G. Slater, Waupaca; secretary-treasurer, H. C. Winter, Madison. Mem-

bers of the executive committee were elected as follows: W. J. Bell, Baraboo, committeeman-at-large; C. W. Twining, Monroe; F. H. Sweet, Fond du Lac; J. C. Harper, Madison; William Lohmiller, La Crosse; B. R. Lewis, Rhinelander; John M. Baer, Appleton; Senator J. C. Gaveney, Arcadia; H. H. Stewart, West Superior.

Mr. Slater, chairman of the committee for considering combination toll rates and the division thereof, reported that further investigation was necessary and requested that the committee have until the next meeting, in June, to make a report.

Mr. H. R. Ritter, superintendent of the Dane County Telephone Company, Madison, read a paper on "Telephone Construction and Maintenance." He advised strongly for using good material and putting in the best construction, and said that different kinds of instruments should not be used in the same exchange. The independents have the pole lines, and should now string copper circuits for long-distance lines and use the iron circuits for the local toll business. The paper was discussed by Messrs. Keelyn, Gaynor and Slater.

Mr. Valentine, the newly elected president, made a short address thanking the delegates for the honor they had bestowed upon him and vouching that he was a thoroughly independent telephone man and strong against any affiliation with the Bell company.

Mr. C. W. Twining then spoke of the plans for extending the lines of the Badger State Long-Distance Telephone Company.

Mr. H. G. Slater read and discussed an article from the *Commercial and Financial World* on telephone affairs, showing that independent telephone properties were fast coming into prominence as investments for capitalists and the money loaning public.

Mr. E. R. Conklin spoke of his work in Illinois in securing franchises in Peoria and Springfield and spoke of the system being put in by his company. His company expects to extend its toll lines northward to Beloit and connect with the systems of Wisconsin. This company has also extensive farmers' systems, usually putting ten telephones on a line.

On motion the convention then adjourned *sine die*.

The following firms opened headquarters at the Hotel Pfister, and entertained their friends:

Farr Telephone and Construction Supply Co., Chicago—Mr. Farr in charge.

Stromberg-Carlson Telephone Manufacturing Co., Chicago—Messrs. Nate and Munsell.

Columbia Telephone Manufacturing Co., Chicago—Messrs. Nolen and Mason.

Illinois Electric Co., Chicago—Mr. Bacon.

Standard Telephone and Electric Co., Madison, Wis.—Messrs. Parish and Taylor.

Electrical Supply Co., Madison, Wis.—Mr. Burch.

John A. Roebling's Sons Co.—Mr. Abbott.

Julius Andrae & Sons, Milwaukee—Messrs. Andrae and Schmidtburger.

American Electric Telephone Co., Chicago—Mr. Speed.

The Green Telephone and Electric Manufacturing Co., Milwaukee—Messrs. Green and Hemsing.

Electric Appliance Co., Chicago—Messrs. Dinsmore and McMullin.

Bell Telephone Mfg. Co., Baraboo, Wis.—Mr Bell.

Illinois Electric Specialty Co., Chicago—Mr. Patton.

W. H. Crumb & Co., Chicago—Mr. Crumb.

Dearborn Electric Co., Chicago—Mr. Messer.

Sterling Electric Co., Lafayette, Ind.—Messrs. Doolittle and Taylor.

Keelyn Telephone Mfg. Co., Chicago—Mr. Keelyn.

M. B. Austin Co., Chicago—Mr. Meinema.

American Electric Fuse Co., Chicago—Messrs. Jones and Rodomer.

Williams-Abbott Co., Cleveland, Ohio—Mr. H. C. Dodge.

Chicago Telephone Supply Co., Chicago—Mr. Briggs.

Swedish-American Tel. Co., Chicago—Messrs. Overshiner.

H. T. Paiste Co.—Mr. Jenkins.

H. C. Hackney, Milwaukee.

Kellogg Switchboard & Supply Co., Chicago—Mr. Platt.

F. Bissell Co., Toledo, Ohio—Messrs. C. A. Peckham and M. S. Walker.

Central Electric Co., Chicago—Messrs. J. W. Mason and S. Mirlin.

Continental Telephone Construction Co., Chicago—Mr. F. B. Patten.

Ericsson Telephone Co., New York—Mr. C. M. McNeil.

Peerless Electric Telephone Co.—J. H. Robertson.

Northern Electric Construction Co., West Superior, Wis.—Mr. J. C. Crowley.

Western Electric Supply Co., St. Louis—Mr. Wm. Wilson.

News from Great Britain.

(By Our Special Correspondent.)

THE deplorable accident on the Liverpool Overhead Railway by which, through the burning out of one of the motors, a whole train was burnt in a tunnel and several lives lost, has started afresh that campaign of letter writing to the daily press picturing the terrible consequences of the introduction of electric traction which periodically makes its appearance on the slightest pretext. It was apparently fanned into life by a well-intentioned leader in the *Times*, which pointed to the need of greater facilities than at present prevail in the case of a similar fire taking place in such a tunnel as that of the Central London Railway. This guided the imaginative instincts of a certain class of gentry into the proper groove, and the decidedly grave possibilities under various almost impossible conditions which immediately followed are worthy of being handed down to posterity. And then, a few days after, as if only to demonstrate that danger is not always a necessary adjunct to a fire on an underground electric railway, a locomotive on the City & South London Railway fired, but was very quickly detached, no harm being occasioned to any one in spite of the bold headlines in the evening papers.

Reverting to the Liverpool accident, one thing was made abundantly clear at the Board of Trade enquiry into the catastrophe, *viz.*, that the two unfortunate passengers who met their death had plenty of time in which to make their escape, and that only the promptings of their curiosity for a closer investigation of the fire brought about their fate. Unhappily four employés also met their death, the fire being aggravated by the fact that a regular hurricane was blowing into the tunnel—only a short one—at the time. The company is to be deeply sympathized with, as this is the first serious accident of any kind which has taken place on its lines.

The Light Railways Act (1896) expired at the end of 1901, but a bill introduced by Mr. Gerald Balfour extended the period for another year. It is quite obvious that at the present ever increasing application of electricity as a motive power for tramway purposes this industry must be more adequately catered for legislatively than it is under the Tramways Act of 1870 or the Light Railways Act of 1896. A forecast of this is provided by the appointment of a departmental committee of the Board of Trade with the object of ascertaining what additions or amendments it is desirable to propose to the bill of 1901.

In view of the number of the correspondence classes which exist in and have been initiated in America for the dissemination of electrical knowledge, it may be of interest to record that Professor Jamieson, of Glasgow, has started up a series of similar classes in electrical and mechanical engineering.

The accompanying photograph gives a view of the boiler-house in the Macdonald road electric light station of the Edinburgh corporation, the chief feature of which is a very fine example of a British made coal elevating and conveying plant, a portion of which is seen in the illustration. This plant is operated by means of Westinghouse electric motors of six and three-quarters horse-power each. Every part of the equipment is duplicated and the gears are encased in oil baths. Besides dealing with the coal in this way the ashes are also got away, and taken as a whole, the new conveyor company, the makers and Messrs. Kennedy & Jenkins, the designers, are to be congratulated.

At the moment of writing some doubts exist as to what is going to happen in connection with the London telephone service so far as questions in Parliament are concerned. The Lord Mayor of London who originally intended moving a question praying for cheaper rates and a quashing of the agreements between the company and the Post Office seems, according to a rumor, inclined to drop it, but if this

happens the London Liberals intend to push the matter on with the hope of getting a select committee appointed to enquire into the matter.

In November and December last year some severe storms caused great inconvenience to the telegraphic and telephonic systems of the country, and with a view to ascertaining the precise damage and the probable cost of it, a question was put in the House of Commons. From the reply it appears that in all the loss of revenue to the Post Office was some £8,000, while the cost of repairs is estimated at nearly £30,000. The principal breakdown occurred on the northern telegraphic circuits in December.

Electrical engineers volunteers continue to be sent out to South Africa, and no difficulty whatever has been experienced in obtaining the necessary numbers for each detachment. Several members have been selected for somewhat remunerative civil posts since their arrival in South Africa, and this may, to a certain extent, have acted as a mild stimulant.

The opening of the permanent home of the National Physical Laboratory has been fixed for March 19, when the Prince of Wales has promised to attend at Bushey House for this purpose. Bushey House, which was given by the late Queen Victoria, has cost nearly £20,000 to refit, and the whole of the work of the laboratory will now be transferred here, most of it having as yet been carried on at Kew Observatory.

Mr. Arthur Wright, the well-known inventor of the "Wright" maximum demand indicator system of charging for electric current, recently read a paper before the Institution of Electrical Engineers extolling the virtues of this method over the ordinary "flat" all-round rate. The subject is an intricate one beyond question, and, as one speaker in the discussion pointed out, weeks of study were necessary in order to grasp the fundamental principles of such a system. Mr. Wright's statement as to the contrariety of opinion among electrical engineers was amply borne out in the criticisms which followed it, and the advocates of either side were pretty evenly balanced as regards numbers. The whole trouble is that the "Wright" system is a little beyond the intelligence of the average consumer of electric current, and as a result it is seen that he would rather pay a little more (unknowingly) for something he can understand, *i. e.*, a "flat" rate than is the charge which would probably be less on the other system, but under which he is bound to feel he was leaving himself to a certain extent in the hands of the electrical supply undertakers. A very fair proportion of the speakers in the discussion appeared to regard the "Wright" system as capable of application within limits, as the effect of this tariff upon a certain class of consumer was very inconsistent.

A. W.

January 25, 1902.

Boiler Room, the Macdonald Road Electric Light Station, Edinburgh, Scotland.

A new coalfield has been discovered in the district of South Worcestershire, lying between Chipping Campden and Moreton-in-the-Marsh. At the instance of the principal land-owners—Lady Northwick and Sir P. Van Notten Pole—Mr. Freeman Mitford, an expert, has been employed, and he has reported that coal exists within workable distance of the surface.

SHEIKS ISLAND POWER PLANT.

BY F. H. LEONARD, JR., E. E.

On January 11, 1902, a party of prominent engineers and managers of electric power plants were the guests of the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, on a trip to visit the power plant designed for Mr. M. P. Davis by Messrs. T. Pringle & Son, Montreal, Quebec. A special Pullman car took the party from Montreal and was met at Cornwall by Mr. Davis, who had brought with him from Ottawa, in a special Pullman car, some of his friends and a number of government officials.

The whole party drove in open sleighs from Cornwall, along the canal bank, to the power-house at Milleroches, a distance of about six miles, inspecting on the way the construction of the transmission line and arc lamps hung for lighting the canal banks and locks and the switch cabinets and transformer houses placed at the various locks for controlling the electrically operated mechanism for opening and closing the gates and operating the weirs.

The large rotating-field generator has a capacity of 1,000 kilowatts or about 1,350 horse-power, and runs at 180 revolutions per minute, having forty poles and giving a frequency of sixty cycles per second, delivering current at the bus-bars at a potential of 2,200 volts.

The exciters have a capacity of fifty kilowatts and are sufficient to excite four generators similar to the one described above. Two exciters have already been installed, so that in case of accident to the exciter or wheels connected with it the other unit can be immediately put into operation to take the place of one which might have been accidentally disabled.

At the switchboard connections are made with cables leading to the wire tower, on the second floor of which are located the raising transformers, which increase the pressure from 2,200 volts to 11,000 volts for the power transmission circuits, and to 8,800 volts for use in connection with the 100-light circuits of series enclosed alternating arc lamps, 250 of which are at present distributed along the canal banks and at the locks, bridges and guard-gates for lighting the Cornwall Canal. The power circuits distribute current for operating canal gates, swinging the bridges and controlling the weirs at the various points from lock No. 15 to lock No. 21, a distance of about eleven miles, step-down transformers being provided at the locks to reduce the line pressure from 11,000 volts to 550 volts, at which it is used in the induction motors. This work does not utilize the full capacity of one generator, but it is proposed to shortly install additional generator capacity so as to provide power for other enterprises which are now operating by steam, or which may later be attracted to the spot by moderate priced power delivered electrically in shape ready for utilization in various classes of industry.

The power-house building is forty feet by ninety feet, built of brick above the line of cut stone arches over the tail-race, and has a steel frame which supports a twenty-five-ton traveling crane running the whole length of the building, and is covered by a steel trussed roof of heavy plank, the whole construction being practically fireproof.

On the side of the power-house next to the head-race is located a steel framed tower, thirteen by fifteen feet, with brick walls three stories in height, the lower story of which is occupied by the high-potential switchboard, the next story with step-up transformers and the top story is devoted to lightning arresters and distributing the ends of cables on to cross-arms which support the transmission lines so that they leave the tower from the two opposite sides to serve lines running in opposite directions from the power-house.

The main floor of the power-house is occupied by the generators, exciters and governors for the water-wheels, the bulkhead extending about eight feet into the power-house, the top of which, at an elevation of about nineteen feet above the main floor, serves as a switchboard gallery, the width being increased about four feet by brackets, over which the floor is extended, communication between the gallery and main floor being obtained by means of an iron staircase at the centre, with brass railing, which also extends around the gallery to both ends of the power-house, where there are iron ladders on the face of the bulkhead, giving additional means of communication from the generating floor to the switchboard gallery.

The switchboard is of the Wagner type, with illuminated dial dead-beat instruments for indicating the current in each phase on the generator panel, a voltmeter switch being provided, so that the single voltmeter indicates the voltage on any phase. Totaling wattmeters are also located on the generator panels, as well as static ground detector, synchronizing lamps and main switch of the oil type and double-break knife switch for generator fields. A double-throw switch provides for lighting the station either from the exciter circuits or from a transformer on the generator circuit. The exciter panel has a direct-current voltmeter and ammeters for each exciter, with double-throw switch, so either exciter can be used with any generator or both can be run together to excite all the generators. The feeder panels have ammeters in each phase and oil switches for opening and closing the circuits, as well as expulsion fuse blocks in each phase.

One panel feeds the Milleroches power and lighting circuit at 2,200 volts, another connects the 11,000-volt, step-up, air-cooled transformers in the tower with the 2,200-volt bus-bars, while another connects the three sixty-kilowatt, 8,800-volt arc lighting transformers to the bus-bars, space being left for five additional feeder panels.

The arc switchboard and regulators are located beyond the space left for additional generator panels at the left of the gallery, the circuits being controlled by plug switches which are also used for making up connections to the transformers. Hot-wire ammeters are used to indicate the current in each circuit and a static ground detector provided with plugs for each circuit. The arc regulators are finely finished with blue Vermont marble tops to match the switchboards and polished brass trimmings.

In the lower floor of the tower is located a high-tension plug switchboard with enclosed fuses for making up circuits on the 11,000-volt power lines, and for connecting primaries of transformers to cables; but these switches will seldom, if ever, be used for opening circuits as the oil switches on the main switchboard will serve to open the circuit on the low-tension side at the bus-bars. It is expected later to install dummy panels in the main switchboard to operate electrically controlled automatic overload switches built in brick compartments in the tower.

The lead-covered cables connecting the dynamos and exciters with the switchboard are hung in brackets located in trenches left in the concrete and ascend on the face of the bulkhead, where they are distributed from a central point in either direction through a trench back of the switchboard, which is covered with hardwood gratings, oiled and shellaced. The cables are also supported in brackets and stanchions in regular order in this trench, which also conducts the cables from the switchboard into the space below the ground floor of the wire tower, up the sides of which the cables are supported on insulated brackets until they reach the top floor where the three wires in each cable are separated at the cable-heads and con-

nected to the outside lines on the arms inside near the ceiling of the top floor.

The line construction is plain and substantial. Shaved cedar poles are used, with the exception of a few iron structures at the bridge piers and locks. All poles on curves are guyed with galvanized signal strand, and where guy stubs are not used two globe strain insulators are used to insulate the guys anchored in the ground. The upper cross-arm carries the two three-phase 11,000-volt lines, and the arm below carries the arc circuits, except near the two ends of the line where one-half of the arm is used for three-phase and the other for arc circuits. No. 6 (medium hard-drawn) bare copper wire is used for both arc circuits and power feeders supported on four and one-half-inch triple petticoat glass insulators. The total line-drop is about five per cent and in some cases less, but on account of mechanical strength it was not deemed advisable to reduce the size of the copper.

A line of barbed wire is stretched the whole length of the line on insulators on the pole tops and grounded at every fourth pole as a protection from lightning, though lightning arresters are provided at the power-house and at the cable crossings.

The high-potential lines cross the canal in paper-insulated lead-covered and armored cables, and provision is made for tying the lines together at various points so that in case of breakdown the lines can be connected so as to work around the point in trouble.

At each lock little substations or cabins are located to contain the transformer fuseboards and switchboards for controlling the motors for operating the gates, etc. These cabins also serve to cover the joint in the cables, which passing through the floor go underground to the masonry walls of the locks, then through the course below the coping stone and down the spare top-log checks at the head of the lock crossing on the bottom out of danger of injury as they are below the level of the top of the breast wall and covered with a ten-inch by twelve-inch timber, thence up the other side in the check in the masonry to the same level as the starting point, then through the wall and earth into another switchboard cabin on the island between the two locks, the motors on each side of the two locks and at the weirs being controlled from separate switchboards, though the cabins between the two locks, side by side, contain switches for motors operating one side of each lock.

The three-phase high-potential is reduced in a bank of three transformers from 11,000 to 550 volts, and only the lower voltage distributed about each group of locks, except for series arc lighting which crosses back and forth for each lock and bridge pier.

Near the easterly end of the line a spare cable is laid across in a trench dug in the mud bottom of the canal to connect the circuits on the north bank to the south bank in case of trouble in either line.

The horizontal water-wheels for this plant were furnished by the William Hamilton Manufacturing Company, Limited, of Peterborough, Ontario, and operate under a working head of thirty feet. They are arranged in two pairs, with a fifth wheel used only in case of high back-water, the draft tubes of which pass through the concrete arches below the floor of the power-house and empty into what was formerly the river-bed of the St. Lawrence, a dam having been built just above the power-house by the government for the purpose of widening the canal, which cut off the channel between the Canadian shore and Sheiks Island, leaving a large lake on the upstream side of the power-house, so that with the still water in this lake troubles from ice, which are such frequent evils in connection with most Canadian power plants, will be entirely overcome.

The Cornwall Canal is part of the deep waterway system of the St. Lawrence connecting the Great Lakes with ocean navigation at Montreal, and has locks capable of handling vessels 250 feet long, 50 feet wide and drawing 14 feet of water.

The head-race for M. P. Davis's power-house is cut from the broad channel leading to the canal waste weir and is paved with stone on a slope of two to one to protect the banks. A steel frame supports the fine racks, back of which are located the head gates, operated by heavy gearing, which admit of cutting off the water from any of the four wheel chambers to admit of inspection or repairs of any of the wheels. Valves are provided for drawing off the water after the gates are closed, as well as valves for refilling. The register gates on the wheels are operated by rods passing through the plates in the bulkhead, where they are attached to the Lombard governors for regulating the speed.

Lunch was served at the power-house, after which many speeches were made, expressing admiration of Mr. Davis's enterprise. Much admiration was also expressed in connection with the Bullock generator and the arc lighting system of the General Incandescent Arc Light Company, of New York.

SEEKING GUTTA-PERCHA.

BY GEORGE E. WALSH.

The building of the new Pacific Ocean cable will cause quite a drain upon the world's supply of gutta-percha, and there is some concern among dealers as to the ultimate effect this may have upon both the price and future supply of this most important material. It is estimated by the cable company which is really engaged in manufacturing the great cable that at least 3,000,000 pounds of gutta-percha will be required for the operation. Not a little of the concern regarding the future of gutta-percha is experienced by the army officers stationed in the Philippines in connection with the Signal Corps, which has been instrumental in laying many miles of cables along the coasts of the different islands at a cost exceedingly small. They have been able to get their supply of gutta-percha at Singapore, but if the demand should unexpectedly double within a few months it is feared that the present activity of cable laying in the Philippines will be seriously handicapped.

One important feature of the question, however, has recently been called to the attention of the Signal Corps department at Washington which presents a rather more unfavorable aspect to the subject. The Singapore merchants have been for years securing their supplies of crude gutta-percha from some of the islands of the far east, and they have tried to keep secret the source of their valuable material. It is now understood that this gutta-percha is obtained from several of the southern islands of the Philippines, and that the natives gather the crude product and sell it to the dealers for a mere nominal sum.

The forests of the trees grow on these islands in considerable numbers, and the exact extent of the supply is only approximately estimated. The Signal Corps department in the Philippines has taken steps to investigate the subject to find out the true value of the forests. If the trees are found there in sufficient numbers, and a chemical analysis warrants it, the new forestry division in the Philippines will take general supervision of the forests to prevent their ruthless destruction. It is believed that the gutta-percha forests may prove a great value both to the natives who work them and the government.

The actual supplies of gutta-percha are such as to cause considerable alarm at times to those engaged in cable laying and manufacturing. So long as this industry is dependent upon gutta-percha for its successful prosecution, the question

of conserving and protecting the trees will be of importance. It is only in recent years that the demand for the substance became so general that there was any danger of exhausting the supply. But now the cultivation of the trees is a matter that has attracted the attention of a number of nations, and efforts have been made to introduce the trees in countries where they have never before been found.

The area in which the gutta-percha trees grow naturally is very limited, and even the regions where they can be made to thrive artificially are very small. The original home of the gutta-percha trees is in the Malay Archipelago and the Malacca Peninsula. In all other parts of the world where the trees have been found they have been transplanted there by accident or enterprising travelers or planters. Thus the Dutch and French have tried repeatedly to introduce the trees in their possessions in the tropical parts of the world. The French transplanted the trees to the Congo region, and also to the West Indies and French Guiana. Some five years ago a large number of the young trees were carried from Singapore to Cochin China by the inspector of French agriculture where they have since thrived. The Dutch were also instrumental in transplanting the trees to their several East Indian possessions. A number of expeditions were sent out half a dozen years ago, and the plantations established by these expeditions have apparently proved successful. The trouble is that these experiments have all been made within recent years, and it is too early yet to determine whether or not they will succeed.

There is no question but the gutta-percha trees will thrive in parts of the world where they were not first placed by nature, and in time plantations of them may be established sufficient to meet all modern requirements. Scientists have, in recent years, thought that some good substitute could be found for gutta-percha in cable laying, and partly relying upon this expectation, the efforts to establish new plantations have not been pushed forward as rapidly as they otherwise would have. Search and experiment have been made continuously for some substitute for gutta-percha, and scientists are laboring in the field to-day to make the discovery which will make them rich. But there is absolutely no other substance known or invented for cable covering and insulating which will begin to give the same satisfaction as gutta-percha. So the deep-sea cables are as dependent upon the substance for their success as in the days when the first Atlantic cable was laid. A peculiarity of gutta-percha is that it deteriorates very slowly. Cables that have been in the deep sea for years have been taken up, and the gutta-percha was found in as perfect condition as when the cables were first laid. This durability of the insulating and protecting material makes it difficult for any substitute to be found. Even after laying under the seas for ten and twenty years it neither loses its elasticity nor insulating qualities, and this is a consideration of the utmost importance.

Cable repairing, of course, is conducted on much better lines to-day than formerly, but even with our fine repair ships and implements it is a pretty costly trip to pick up a cable and repair it. Consequently, the necessity of making the cables in the first place as durable as possible is of prime importance. When it is remembered that the very slightest imperfection in the insulating covering may very soon become a source of trouble, remedied only by taking up a portion of the cable and repairing it, the value of perfect gutta-percha insulating material which will neither break, crack nor stretch out of position is apparent. It would take a material that had been experimented with for years before cable companies would accept it as a substitute for gutta-percha which has been used for decades.

The gutta-percha belt where the trees grow naturally is in the tropical part of the world, and the exports have steadily increased from that region for the past half century. Our cable-making industry can be measured to a certain extent by the exports of the gutta-percha, for practically this industry absorbs about all of the substance. Between 1850 and 1864 the exports of gutta-percha from the restricted region where the trees grow were merely nominal, amounting to only a few hundred tons a year. In 1865 the exports amounted to 1,800 tons, and the amount increased slowly until 1882 when the total exports were 3,800 tons. Then shortly after the cable-laying industry became an important factor, and the demand for gutta-percha rapidly increased. In 1890 the world's use of gutta-percha for cable insulating amounted to 45,000 tons per year, and since then the amount has advanced until to-day the average annual consumption runs from 50,000 to 65,000 tons. This amount means the destruction annually of some 100,000 trees or of forests which would take half a century to replace.

Prices for gutta-percha have increased in proportion to the demand. Between 1876 and 1882 the price just doubled, and up to 1890 it had made a further advance. In the last decade it has increased about one-third more. The building of the new Pacific cable will probably give another upward turn to the price. This advance is a legitimate movement of the market because of the relative scarcity of the substance and the crude methods of protecting the forests. Most of these have been in the hands of natives who are both ignorant of the value of the trees and of scientific methods of gathering the gutta-percha without definitely destroying the trees.

The lower islands of the Philippine group touch pretty closely on what has always been termed the gutta-percha zone, and the discovery of the trees growing on a few of these islands indicates that an infant industry may soon be established there under the direction of our agricultural department that will prove of the greatest financial value to us. Most of the gutta-percha received at Singapore has been obtained in the past from these southern Philippine Islands, and this has been considered equal in quality to any imported from the far east.

The trees are so exacting in their demands that soil and climate must be just right for their success, and few other parts of the world have been found to furnish these in proper proportions. Sudden changes in temperature retard the growth of the trees so that plantations rarely ever come to maturity; but where the soil and climate are suitable the trees are luxuriant and rapid growers, repaying the planters for their time and expense in a short time.

Electrical Phenomena in Cosmogony.

In a paper on the energy of the universe in the *Revue scientifique,* M. I. Skvortzow discusses the influence of electrical phenomena in cosmogony. He considers that in the past history of the earth, and of other celestial bodies, electrical and chemical energy have originally played the most important part, and that heat energy has become more and more important in proportion as the earth has assumed a more material form, so that the more its energy has passed from the dynamic to the static form the greater has been the absorption of dynamical energy in overcoming resistances. The heat of the earth M. Skvortzow attributes to electric currents circulating mostly near the surface; the interior of the earth, on the other hand, he thinks may be as cold as the greatest depths of the ocean. Changes in the aspect of the earth, as well as meteorological phenomena, are attributed to electric currents induced by solar influence. The temperatures of different planets are considered to depend less on their distance from the sun than on their reserve of energy and on the currents which the sun induces in them in virtue of their axial and orbital motions. Will this theory of the electromagnetic origin of the earth's heat reconcile the two opposing views on the age of the earth?

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motor Carriages at the Chicago Automobile Show.

The International Motor Car Company has arranged a very elaborate display for the Chicago Automobile Show, to be held in the Coliseum from March 1 to 8 this year. The name of this company was so recently changed that the public generally has hardly had time to realize that the factories at Toledo, Ohio, where the Toledo steam carriages are built, and at Indianapolis, Ind., the home of the Waverley Electric, are both included when the International Motor Car Company is mentioned.

The entire exhibit at Chicago is to be very artistic, and while each division of the company will have a complete line of vehicles on exhibition, they will be so arranged that the whole will make a very striking display. The general designs are already well along for the booth, and it will probably be more elaborate than the exhibit at the Madison Square Garden show.

The Waverley portion of the exhibit will include a little light road wagon of the well-known type, and a vehicle of similar construction with a phaeton top. A delivery wagon of new design will also be included in the exhibit, and a substantial surrey fitted with artillery wheels and otherwise up to date.

The Waverley department has under construction a vehicle of entirely new design which is expected will make a sensation in trade circles, and which it will exhibit at Chicago.

The Toledo department will have on exhibition its standard Model A Toledo steam carriage, such as was selected for the trip through the Grand Cañon and the Yosemite Valley. It is a vehicle of this type that was selected for the journey from Toledo, Ohio, to Hot Springs, Ark. The Toledo exhibit will also include a standard Model A with phaeton top and a surrey of somewhat improved design, although very similar to the one that was exhibited at the Madison Square Garden show.

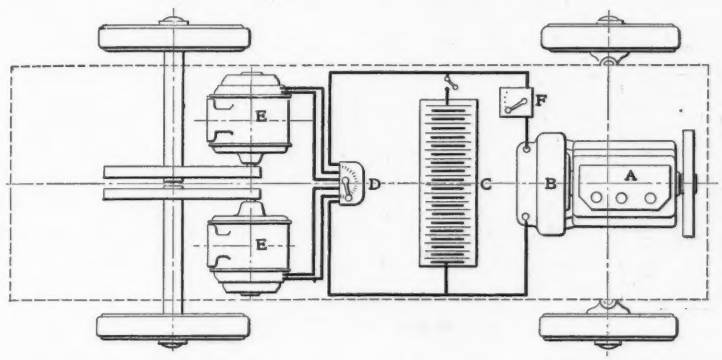


FIG. 1.—DIAGRAM: A-ENGINE; B-DYNAMO; C-BATTERY; D-CONTROLLER; E-MOTORS; F-ENGINE-STARTING SWITCH.

The Toledo Junior will be a prominent exhibit of this company. This is a neat little vehicle of light construction for general city and town use; in fact, it is designed to fill the same field for which the other well-known light vehicles are designed. The Toledo Junior is equipped with a boiler the same as the regular Toledo Model A, excepting that it is of lighter steaming capacity. The frame of this carriage is of the well-known type previously shown on some of the Toledo models. It is very flexible and the vehicle is very easy riding. The Toledo Junior weighs about 850 pounds. A new model Toledo that will be exhibited for the first time at the Chicago show is the dos-a-dos. The lines of this machine are very attractive.

FIG. 2.—SHOWING RUNNING GEAR AND STEERING APPARATUS.

A New Combination System Automobile.

Among the number of automobiles to be seen in daily operation, the close observer will notice the very small percentage devoted to business purposes or for heavy trucking. That there is a demand for heavy motor vehicles there can be no doubt, for in these days of keen competition, anything that will show a saving in cost of operating as compared with horses and at the same time relieve the congested condition of busy streets will be welcomed by the progressive business man. But it is necessary to have a vehicle that is absolutely reliable, easily handled and economical. The problem of power ap-

parently solved in light pleasure vehicles is found to be much more difficult to meet in heavy ones.

Realizing the limitations from which both gasoline and electric motors suffer, the Fischer Motor Vehicle Company has for the past five years been perfecting a combination system. This system, it is claimed, possesses all the good qualities of the electric and gasoline combined, while eliminating by the combination the disadvantages inherent to each alone.

Fig. 3.—Finished Eighteen-Passenger Omnibus.

Fig. 1 is a diagram illustrating this system, which consists of a combined gasoline engine and dynamo, one motor for each (rear) drive-wheel, a small storage battery and controller. The advantages claimed are that there is no mechanical connection between the engine shaft and vehicle drive-wheels, therefore the dynamo is free to run at a practically even speed, producing a constant supply of electricity. The electric circuit is so arranged that when running the vehicle under normal conditions (loaded, on the level) the current goes directly from the dynamo (through the controller) to the motors, but when coasting down grade, slowing up or, in general, when less power is needed than that furnished by the engine, the current is automatically taken up by the battery which is connected to the wiring at a point between the dynamo and controller. Again, when extra power is needed, as in ascending steep grades or starting heavy loads, the battery promptly furnishes the deficiency. This action (carrying the peak of the load) does not have to be watched by the operator, being entirely automatic. As the output of the engine does not vary no governor is required and the gas and air mixtures can be set permanently for perfect combustion; this ensures great saving in fuel and prevents the usual bad odor. As the speed of the engine is almost constant the balance will be practically perfect, preventing vibrations. The starting of the engine, by simply throwing in a switch controlled by the driver, is also claimed to be a very important feature.

Fig. 3 shows an eighteen-passenger omnibus recently completed. The vehicle and its full equipment, excepting the batteries, were designed by its chief engineer, L. G. Nilson, and built at the company's Hoboken shops.

Fig. 2 is a photograph of the standard running gears which consist of an angle steel under frame to which various parts of the machine are attached. The front portion carries the gasoline engine, dynamo, controller and steering gear. The front axle, instead of the usual heavy forging, is trussed somewhat on the principle of a bridge and carries extra long and flexible platform springs bolted to the brackets on the frame. The rear axle, with the wheels, spring, two motors and reduction gears, forms a complete driving unit. All parts subject to wear are entirely encased so as to be properly lubricated and at the same time protected against dust and moisture. No reach is used, the half elliptic springs conveying the power from the rear axle to the frame. The water cooler is suspended under the frame between the front and rear axles. The illustration, Fig. 2, shows the running gear complete in every respect, and Fig. 3 the body in place, making a finished bus.

The power equipment consists of a ten-horse-power three or four-cycle gasoline engine running 600 revolutions per minute. All wearing parts are extra large, provision is made for taking up wear, lubrication is entirely automatic and the general construction designed for constant work with a minimum amount of care. Directly on the engine shaft is placed the armature of a five-kilowatt 110-volt dynamo. The motors are of a special "twin" type (built together), five horse-power each and will stand an overload of 100 per cent for a half hour, or 200 per cent for five minutes, without sparking at brushes. The controller is of the series parallel type of five forward speeds from two and one-half to ten miles per hour and two reverse speeds from two and one-half to five miles per hour, all controlled from one lever. The batteries consist of fifty cells of ninety ampere-hours capacity. The front wheels are thirty-eight inches and the rear forty-six inches, equipped with four-inch Calumet solid rubber tires.

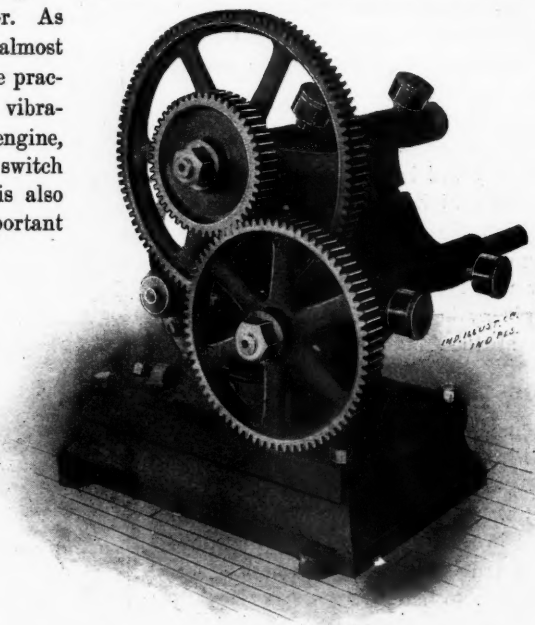


Fig. 1.—Motor with Reducing Gears.

Reducing Gears and Enclosed Motors.

Careful study is being made of the conditions and requirements of modern manufacturing and industrial establishments, with a view to constructing a motor which will embody features specially adaptable to give satisfactory and efficient service under all reasonable conditions with a minimum of attention, and which can also be adapted to any form of drive. In Fig. 1 is shown an application of reducing gear with the Jenney Universal motor, manufactured by the

FIG. 3.—ENCLOSED MOTOR, WITH VENTILATING HEAD.

Jenney Electric Manufacturing Company, Indianapolis, Ind. A large number of these motors with double reducing gears has been installed for driving lathes and other machine-shop tools, where slow speeds are desired, without the excessive cost of an ordinary motor wound for exceedingly slow speed.

When protection against moisture, dust or any other foreign substances is desired, a type of enclosed motor is most desirable. Fig. 2 shows the Universal motor with enclosed head. A number of these motors has been installed in tanneries in Philadelphia, and also in grain

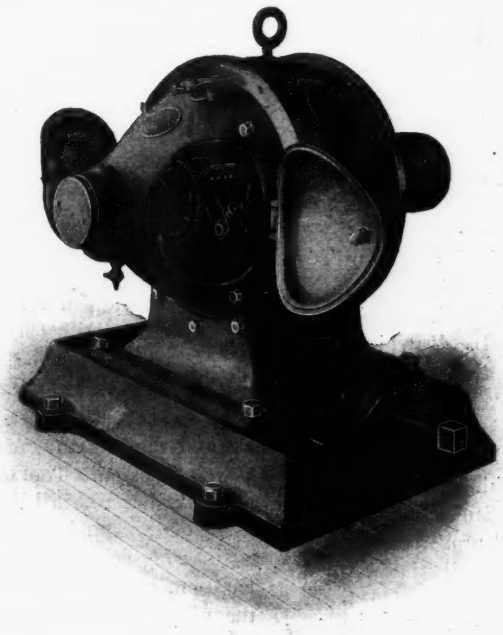


FIG. 2.—ENCLOSED MOTOR, WITH VENTILATING HEAD OPEN.

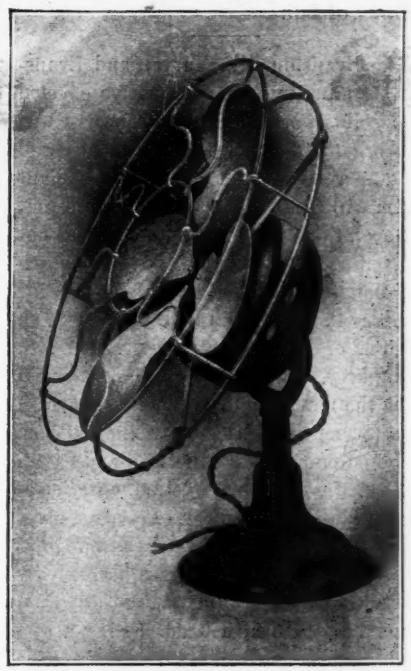
elevators and other places where protection is desired, not only against moisture but against explosive and inflammable dust. When protection is desired only against larger particles such as motors would be subjected to connected to printing-presses and punching machines, a type of Universal motor with ventilated head, as shown in Fig. 3, is designed.

The frame of this motor is spherical and consists of a single casting. The circular bands or flanges cast on the sides are turned true to gauge and are drilled and tapped around the entire circumference to receive the supporting foot. The supporting foot is cast separate and may be attached to any part of the frame desired. This construction permits the motor being mounted on ceiling or side walls, or at any angle required.

The bearings are of phosphor-bronze and interchangeable, and are self-aligning and self-oiling. The armature cores are built up of plates stamped out of a special grade of soft annealed steel, are accurately notched to receive the coils and are magnetically insulated from the shaft and mounting by brass clamps. The coils are form wound and thoroughly insulated before being placed on the core. Large commutators are used, built up of pure lake copper bars, carefully insulated by selected mica strips. The field coils are wound on metal spools with brass flanges, except the smaller sizes which are form wound and taped. Radial carbon brushes are used on all sizes, and the holders are of a very simple, convenient and effective form, allowing either individual or simultaneous adjustment of tension and position.

Alternating-Current Fan Motors.

The accompanying illustration gives a good idea of a swivel and trunnion type of alternating-current desk fan made by the Emerson Electric Manufacturing Company, of St. Louis, Mo. This company was among the pioneers in manufacturing alternating-current fans. The design of these machines is such as to secure high efficiency and good power-factor, and



ALTERNATING-CURRENT DESK FAN.

the shape of the fan blades is such as to reduce greatly the disagreeable humming noise due to their operation at high speed. The company manufactures many different types of fans for alternating-current circuits.

BOOK REVIEW.

"The Electrician Wireman's Pocket-Book." Edited by F. C. Raphael, London. *The Electrician* Printing and Publishing Company, Limited. Leather. 330 pages. 3 by 7¾ inches. 175 illustrations. Supplied by the ELECTRICAL REVIEW at $2.50.

This excellent book is compiled, of course, principally with reference to the needs of British electrical workmen, so that a large part of its contents is not available for American workmen. Contrary to the usual English custom, this pocket-book is really a book that can be carried in the pocket.

Chicago Electrical Notes.

(By Our Special Correspondent.)

AN interesting bit of news was made public in Chicago last week concerning the work on the tunnels which are being constructed under the city by the Illinois Telephone and Telegraph Company. Work is being pushed from six different points, and it is announced that already more than five miles of this tunnel have been completed in the business section of the city. It is the purpose of the company to install the automatic system of telephones and negotiations have been completed with the Automatic Electric Company, of this city, for 25,000 telephones. The Illinois company proposes to begin the installing of this system at once and expects to be ready for business by the opening of fall.

The Evanston, Ill., Yaryan and Evanston Illuminating companies have effected a consolidation and the two concerns will be reorganized under a new franchise and operate a large light and heating plant which will cost $1,000,000. It is said that the operation of the new company will not be confined to Evanston, but will reach out along the Lake Michigan shore as far north as the Wisconsin line. Mayor E. G. Gorton, of Lake Forest, and Mr. H. S. Humphrey, of Pittsburgh, Pa., are said to be the moving spirits in the enterprise. The former is a director in the Chicago Edison Company and the latter has been connected with the Westinghouse electrical plant in Pittsburgh as general manager. The operation of the two companies in Evanston as rivals has not been a very successful venture, and the consolidation is expected to result in developing a system of heating and lighting which will be mutually beneficial to both stockholders and patrons of the concern.

A peculiar feature of the market here is the remarkable rise in Chicago traction stocks. In spite of the agitation which has been going on for some time, which would generally have had a depressing effect upon these securities, their price has been steadily increasing. The stock of the Chicago City Railway Company showed a gain of twenty-eight points between January 30 and February 15, while the gain in North Chicago Railway stocks during the same period was seventeen points. The West Chicago and Union Traction companies also showed gains, but not so great as the other two. It is hinted that some great financial interests are at work attempting to solve the traction question in Chicago, and the belief that these efforts may be successful seems to be having its effect on the market. Rumors that the Elkins-Widener people were trying to secure control of all the Chicago lines were current for a time. It was also said that J. P. Morgan was in some way connected with the rise in the value of stocks, but these stories seem to lack verification. Meantime the traction situation is more or less chaotic, and the man who can "call" it could put the combination book at any American race track out of business in a very few bets.

In his address to the Independent Telephone Association of Wisconsin, at the annual meeting at Milwaukee on February 19. President A. L. Hutchinson, of Weyauwega, showed the rapid growth of the independent movement in that state, as well as the sound basis upon which this growth has taken place. "There are today," said Mr. Hutchinson, "over 160 distinct telephone companies in Wisconsin, not including several properties owned by single individuals. Full statistics," he said, "had not yet been collected, but reports from ninety of these companies show a mileage of toll lines amounting to 5,548, divided as follows: Grounded circuits, 3,172 miles; iron metallic circuits, 2,203 miles, and copper circuits, 173 miles. There are 130 exchanges, 629 toll stations, and the total number of telephones in operation is 17,763. The capital invested in these enterprises amounts to $1,467,900." Mr. Hutchinson thought that these figures would be increased at least twenty-five per cent as soon as full reports from all the companies could be secured. This is a wonderful showing. There is no end of enthusiasm among the independent people in Wisconsin, and it is safe to say that they will continue to push out along new lines, making all needed improvements, until every city, town and village in the state shall have been reached and connected up.

The movement, begun some years ago, to organize an interstate telephone association to include the western states, has now reached a point where its success is apparently assured. The members of the Illinois Independent Telephone Association, as well as the manufacturers and supply men, are enthusiastic over the project, and last week sent a delegation to Milwaukee to invite the Wisconsin Independent Telephone Association to be present at a meeting in Chicago on April 9, 10 and 11, at which time the big association will be organized. The committee from Illinois which attended the Wisconsin association and asked the cooperation of its members consisted of Dr. I. A. Lumpkin, of Mattoon, Ill., president of the state association; J. J. Nate, H. B. McMeal and S. A. Dinsmore, of Chicago. The invitation received great favor at the hands of the Wisconsin people, and the convention unanimously voted to accept it.

As a mark of esteem and appreciation of his services in the development of machinery in America, the gentlemen who entertain Prince Henry of Prussia at a private breakfast in New York city on the morning of February 26, invited Mr. Edwin Reynolds, of Milwaukee, chief engineer of the Allis-Chalmers Company, to be present on that occasion. Mr. Reynolds accepted the invitation. Mr. Reynolds's career has been a remarkable one. He is seventy-one years of age, and for fifty-four years has worked with zeal and wonderful success in his chosen field. It is his master mind that presides over the engineering department of this great corporation, and the engines he has built—the offspring of his genius—have been sent to all parts of the world to turn the shafts of industry and develop the earth. Mr. Reynolds built a giant 1,000-horsepower engine which is now installed in the big Berlin establishment of Ludwig, Loewe & Company, and this is said to be one of the few large engines ever exported by this country to Germany. It is a compliment to Prince Henry to think that he finds pleasure in the acquaintance of such men as Mr. Reynolds.

The Iowa state telephone convention will be held in Des Moines, March 11 and 12. A full attendance is hoped for as there are many subjects of importance which will come before the convention for discussion.

In the annual report filed last week, President Hamilton, of the Chicago City Railway Company, said that in order to properly subserve the interests of the public a number of changes ought to be made, such as the replacement of a large part of the equipment of the system, the changing of motive power on the lines, better terminal facilities in the business districts of Chicago and "reasonable grants, with such conditions as warrant the expenditure of the several millions required to make investments safe." The report furnished some interesting figures as to income and expenses of the lines for the year.

Chicago, February 22.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

TENDERS FOR CHRISTIANA—The British Consul-General at Christiana reports that tenders are invited for 3,000 metres 1.5 mm. india-rubber insulated copper wire, 4,000 metres seven-strand india-rubber insulated copper cable, 100 kilog. tinned plain copper wire and 150 kilog. three-strand plain copper wire. Tenders should be made to Telegraph Inspector's Office, No. 8 Stenersgade, Christiana.

WINNIPEG RIVER POWER PLANT—Arrangements are said to have been completed with New York capitalists to start immediately the carrying out of the enterprise of erecting large pulp and paper mills and developing some 100,000 horse-power from the Winnipeg River, located about sixty-five miles from the city of Winnipeg, Manitoba. The mills are expected to be in operation within two years and the intention is declared of transmitting power to Winnipeg next fall.

POWER TRANSMISSION IN TENNESSEE—Mr. A. M. Barron, a consulting engineer of Chicago, is engineering a deal by which 10,000 horse-power will be developed in middle Tennessee, and carried, by high-tension service, a distance of 100 miles to an established market. The current will be stepped up from 1,000 to 30,000 volts, then down to 2,000. Two-phase generators will be used and three-phase transformers in transmission, delivering the product two-phase to rotary transformers for traction purposes. Induction motors will be used for power purposes.

CONNECTICUT RAILWAY DEAL—It is understood that a trolley deal has been consummated by which the Meriden, Southington & Compounce Tramway Company has passed into the hands of the Connecticut Railway and Lighting Company, controlled by the United Gas Improvement Company, of Philadelphia. The Meriden, Southington & Compounce road runs from Meriden to Lake Compounce. Its acquirement gives to the Connecticut Railway and Lighting Company, with the exception of the New Haven road, almost a through line from southern Connecticut to Hartford.

CONVERTING FRENCH TRAMWAY SYSTEMS—The Compagnie des Tramways a Vapeur de Saint Etienne, France, the Saint Etienne Steam Tramways Company, is reported to be contemplating the conversion of its system into electric motive power. The Calais Tramways Company, Limited, which concern controls all the horse tramways in the city of Calais, France, is reported to be about to convert the entire system into electric traction. The general manager of the company is M. August Gabriel, Boulevard Gambetta, Calais. The registered offices of the company are at 57 Moorgate street, London, E. C.

RUSSIAN SUBSIDY FOR ELECTRICAL WORKS—An extensive plant for the manufacture of electrical machinery, etc., is now under construction at St. Petersburg. A company has been organized under the Russian laws for the purpose of operating the plant, which will turn out electrical equipment principally for the government. A subsidy of $1,500,000 has been granted by the Russian authorities. The capital of the enterprise is $3,000,000, mostly subscribed by Moscow parties. The plant, which will cover twenty-eight acres and employ some 1,500 men, will, it is said, be one of the most modern and most complete works of its description in Continental Europe. Everything, other than the castings, which will be imported from the United States, will be manufactured at the St. Petersburg factory.

REPORTS FROM OHIO—It is stated in Ohio financial circles that a "securities holding" company planned for the Cincinnati, Newport & Covington and the Union Light, Heat and Power Company merger has been arranged in New York. A company capitalized at $10,000,000, half preferred, with five Cincinnati, Newport & Covington and four Union directors, is to be formed, it is said. Cincinnati, Newport & Covington stockholders will get about par for their stock in preferred shares, the exchange being optional, and Union stockholders are to deposit all their stock at about $50 in exchange for the new securities. The companies will for the present be operated separately. Some stock is to be kept in the treasury and about $100,000 to be held for settlements. The plan will be submitted to the Cincinnati, Newport & Covington stockholders. J. C. Ernst, of Covington, it is said, will be the head of the new company.

AMERICAN ENGINES AND DYNAMOS FOR EUROPEAN LIGHTING PLANT—A recent order of especial interest, illustrating the fact that a constantly increasing demand for American machinery is being created, has been placed with a large New York firm. It provides for a new electric light and power plant at Stockholm, and consists of two 250-horse-power Westinghouse vertical cross-compound engines, directly connected to two Westinghouse generators. As this equipment will follow closely the lines of standard American practice, the Swedish capital will soon have an up-to-date Yankee lighting plant. The plans call for an outfit erected on a rigid and massive bed-plate, the generator armature being mounted on the engine shaft. The engine bearings are adjustable from the lower side so as to preserve alignment with the outboard bearing, and many other features that are commonly found in American lighting plants will be introduced in this station.

PERSONAL MENTION

MR. MARK LOWD, of the Narragansett Electric Lighting Company, of Providence, has recently returned to his home city from a tour of inspection to the electric lighting companies of New York, Buffalo and Chicago. In these cities Mr. Lowd found much in the progressive nature of the electric lighting field to interest him. The Narragansett Electric Lighting Company is one of the best managed large companies of its class and a highly successful corporation.

ELECTRIC RAILWAYS

WASHINGTON, D. C.—The Washington, Alexandria & Mount Vernon Electric Railway Company will, at an early date, commence laying a double track from Spring Park to Arlington Junction.

QUINCY, ILL.—The Quincy Street Car Company has decided to extend its tracks to Walton Heights and also to make a loop through the grounds of the State Soldiers' Home. Work will be commenced at the opening of the spring season.

ALBANY, N. Y.—A certificate of consolidation of the Westchester Traction Company and the Ossining Electric Railway Company, formerly the Westchester Traction Company, was filed with the Secretary of State recently, the capital being $300,000.

SALT LAKE CITY, UTAH—At a recent meeting of the city council a franchise to construct and operate a double-track electric street railway was granted to F. E. Flattery and J. F. McCarron, of Detroit, Mich., and George A. Gibbs, of Salt Lake City.

ROCKLAND, ME.—A company to be known as the Rockland, South Thomaston & Owl's Head Railway has been formed here, which has petitioned the railroad commissioners for approval of organization and a franchise to build and maintain a street railway.

BALTIMORE, MD.—The municipal electrical commission has decided to build the extension of the subway system requested by the United Railways and Electric Company from North and Madison avenues to Druid Hill avenue to the Retreat street power-house.

MARINETTE, WIS.—T. F. Frawley, it is said, has secured control of the White Rapids water power, thirty miles from Menominee, and an electric line will be built from Spalding, Mich., to Marinette, and from Marinette to Peshtigo and Oconto, and ultimately to Green Bay.

ST. LOUIS, MO.—For a consideration of $10,000, paid to the County Court at Clayton, the Terminal Association has been granted a franchise to build a belt line from a point on the St. Charles Rock Road to the western city limits. The work will begin at once, and the cost of the line will be in the neighborhood of $3,000,000.

MARION, IND.—The Ohio & Indiana Traction Company now has a continuous right of way from Toledo, Ohio, to Marion, a distance of 157 miles. The Toledo & Bryan Air Line Company has sold its property to the Ohio & Indiana Company, and the consolidated organization is known as the Ohio & Indiana Air Line Railway Company.

PITTSBURGH, PA.—A charter has been granted in Harrisburg to the Monaca, Beaver & Smith's Ferry Electric Railway Company. The new line will be an extension of the Coraopolis & Monaca Electric Railway from Monaca to Smith's Ferry, at the state line, where it will connect with East Liverpool lines and make a through connection from Pittsburgh to Wheeling.

ELECTRIC LIGHTING

MARION, OHIO—A movement is on foot at present to organize a company here for the purpose of requesting a lighting franchise from the council. Columbus parties are said to be backing the enterprise.

OAKLAND, CAL.—The board of supervisors has granted a contract for lighting the San Leandro road from Oakland to Haywards to the Suburban Electric Light Company for $206.40 per month for two years dating from March 15.

MIDDLETOWN, OHIO—Under an agreement recently effected between the Lancaster Electric Light Company and the Edison Electric Illuminating Company, the latter will have control of all the electric light power in Lancaster County.

SANTA PAULA, CAL.—The Santa Paula Electric Light and Power Company is wiring the town and its residences preparatory to establishing its plant in this vicinity. The change from dark streets to well lighted thoroughfares will be welcomed.

ABERDEEN, S. D.—An ordinance is now being passed by the city council extending the franchise of the Aberdeen Gas Company twenty-five years. Incandescent electric lights are to be furnished in addition to the arc light system now in use.

ESCANABA, MICH.—Outside capitalists have made an informal offer of $70,000 for the municipal electric lighting plant, which since its installation has not been a financial success. Should the company secure the system, extensive improvements will be made.

RENOVO, PA.—After a warm discussion the council, by a vote of five to four, has approved the contract with the Renovo Electric Light Company for lighting the town streets. The contract provides for twenty arc lamps of 1,2000 candle-power, the rate for each to be $78 a year.

HARTFORD CITY, IND.—At a special session of the city council it was unanimously decided to accept the proposition of the American Light and Water Company to purchase the electric lighting system of this city. The company will reconstruct the entire plant, and greatly increase the number of street lights.

SHEFFIELD, ALA.—Mr. F. Brumbach, of Chicago, an expert electrician, has been in Sheffield for some time investigating conditions with a view of installing a modern electric lighting system. It is understood that he will purchase the building and connections of the present plant, but will use entirely new machinery.

GRAND RAPIDS, MICH.—The Peninsula Electric Light and Power Company, of Marquette, has contracted for a new 1,500-horsepower engine, and a 12,000 incandescent light dynamo, and other electrical appliances. During the last two years the company has spent over $100,000 in rebuilding its lines all over the county.

SUMMITVILLE, IND.—The Summitville Electric Light and Power Company has been incorporated and has received its charter from the Secretary of State granting it permission to follow out its line of business for fifty years. This new step adds permanence and assures stability to the enterprise. The company is capitalized at $3,600, the stock being held by the directors, J. W. Gordon, W. C. Gordon and H. E. Howard.

CINCINNATI, OHIO—The contract for the electric light wire cables to be used in the underground conduits in the centre of the city has been let by the Cincinnati Gas and Electric Company. The contract for the underground subways and construction work was let some time ago. The work is to be completed by May 15, and includes that territory between Freeman and Eggleston avenues and Third and Liberty streets.

ONEONTA, N. Y.—One of the largest financial transactions in Oneonta in recent years has just been consummated, and a large bulk of the stock of the Oneonta Gas Company and the Oneonta Electric Light and Power Company and the entire holdings of the Electric Water Company, of Oneonta, have been transferred to N. C. Fletcher, of Providence, R. I., who, it is understood, represents large financial interests of that city.

RACINE, WIS.—Articles have been filed by the Wisconsin Heat, Power and Light Company, with a nominal capital of $25,000; incorporators: Martin Clancy, C. M. Dietrich, Jens Jenson and Peter B. Nelson, to compete with the Milwaukee Electric Railway and Light Company; $175,000 will be expended in the construction of a plant. A heating plant will also be erected, and stores and residences will be furnished with hot-water heating and electric light.

ALTON, ILL.—A new electric lighting company, backed by prominent Alton business men, is being organized for the purpose of furnishing lights in the business district of the city. The new company will be for the mutual benefit of the stockholders and will furnish light at a figure as near actual cost as can be done. Mr. Edmond Beall, a prominent Alton manufacturer, will organize the new company, and with him will be associated many of the most prominent business men of the city.

NEW INCORPORATIONS

MADISON, WIS.—The Green Bay Light and Power Company.

SPRINGFIELD, ILL.—The Citizens' Gas and Electric Light Company, of Madison, Wis. $200,000.

CHICAGO, ILL.—The Western Electric Company from $8,000,000 to $15,000,000 and an increase of the number of directors from nine to eleven.

PEORIA, ILL.—Standard Electric Meter Company. $50,000. To manufacture electric meters. Incorporators: J. H. Blusch, E. J. Ebersol and others.

ST. LOUIS, MO.—The Laclede Power Company. Increased its capital stock from $400,000 to $800,000, the increase being paid up. The company's assets are $840,357.30 and its liabilities $17,528.20.

JERSEY CITY, N. J.—National Light Supply Company, 90 Orange street, Bloomfield, N. J. $50,000. Incorporators: Irving H. Brown, Harry B. Perkins, Wm. E. Billings.

ALBANY, N. Y.—The National Gas and Electric Light Company, of Sandy Hill. Capital, $51,000. Incorporators: Brodie G. Higley, Norman T. Drake and W. J. Gallagher.

COLUMBUS, OHIO—The Greenville, Versailles & Northeastern Traction Company. $1,000. To construct a railroad from Greenville, Darke County, to Loraine, Shelby County.

LOS ANGELES, CAL.—The Pomona & Ontario Light and Power Company. $150,000. Directors: William H. Schweppe, F. O. Johnson, R. B. Dickinson, F. B. Braden, all of Los Angeles, $1,000 each; W. F. Jordan, Riverside, $146,000.

MADISON, WIS.—American District Telegraph Company, of Milwaukee; amendment increasing capital stock from $100,000 to $200,000. Green Bay Light and Power Company; amendment increasing capital stock from $150,000 to $300,000.

DAVENPORT, IOWA—The Davenport & Western Railway Company. To build electric railways in Davenport and to Muscatine, Cedar Rapids, Iowa City *via* Buffalo and Blue Grass. $150,000. Mr. Robert Kercherval is president and other citizens of Davenport are incorporators.

ALBANY, N. Y.—The Lake Erie Traction Company, of Westfield. $101,000. Directors: E. A. Ryan, T. H. Paist, D. B. Saxton, G. D. Howell, S. C. Myers and Hubert A. Clark, of Philadelphia; T. B. Hall, of Camden, N. J.; Maurice E. White, of Norristown, Pa., and William L. Minton, of Westfield.

TRENTON, N. J.—Delaware Valley Traction Company. $100,000, of which $25,000 is paid in. The stock is divided into 1,000 shares of the par value of $100 each. The company proposes to build a line from Trenton to Pennington. Incorporators: W. A. Buchanan, George Buckman and W. F. Sadler, Jr.

BALTIMORE, MD.—The Baltimore & Frederick Electric Railway Company. $1,500,000. To build a line from Baltimore to Frederick, forty-five miles. Incorporators: Frank H. Callaway, John W. Ellard and James E. Ingram, Jr., of Baltimore; Senator J. Beaman, of Carroll County, and J. Roger McSherry, of Frederick.

INDIANAPOLIS, IND.—The Indianapolis Interurban Terminal Company; $50,000; incorporators: Charles Finley Smith, William C. Irwin, Medford B. Wilson, John W. Chipman, Samuel E. Rauh and Alfred M. Glossbrenner. The General Construction Company; $50,000; directors: W. L. Kahn, S. J. Mack, H. C. Stillwell, George Lilly, S. E. Raub, Henry Raub.

TOLEDO, OHIO—The Toledo Electric Railway. $200,000. To build and operate an electric railway from Traer, Iowa, through Toledo and Tama and thence south into the coal regions of Mahaska County, terminating at the town of Buxton. Mr. W. C. Walters is president, Mr. J. R. Caldwell, vice-president, Mr. C. E. Walters, secretary, and Mr. H. A. Shanklin, treasurer. The road is being promoted by Mr. P. E. Hall, of Cedar Rapids, Iowa.

ELECTRICAL SECURITIES

Review of the incidents of the financial week would lead one to conclude that stock held for investment had been thrown on the market; that prices had slumped violently and that Wall street had been demoralized generally. The fact is there was demoralization among petty speculators, but more stocks advanced in value than declined, bonds were uniformly higher and the volume of business was large for normal times. The week began with the severest storm in a decade, which naturally restricted business. The Commissioner of Internal Revenue arrived in the city from Washington to discuss the stamp tax. Traders curtailed operations, fearing collection of tax, and on Thursday came the Washington report that President Roosevelt had requested the Attorney-General to bring suit against the Northern Securities Company. There is, however, no seriously evil spot in the entire situation. The bear arguments are based on sentiment rather than sound judgment. Yet it must be admitted that sentiment frequently has much to do in fixing prices temporarily. Legitimate conditions continue healthful. Trade is active, and, while New York has little surplus reserve to brag about, the interior banks have more money on hand than in any corresponding period in recent years. Any advance in discounts will attract sufficient funds to New York to offset the loss through gold exports.

ELECTRICAL SECURITIES FOR WEEK ENDING FEBRUARY 22.

New York:	Closing.
Brooklyn R. T.	61¾
Con. Gas	220⅞
Gen. Elec	288
Man. El	133⅜
Met. St. Ry	168⅝
Kings Co. Elec	191
N. Y. & N. J. Tel. Co	169
Telep., Tel. & Cbl. Co	5

The *Wall Street Journal* says: "The incorporation of a Westinghouse company to operate in Russia is regarded as a bull card on Westinghouse Electric and Manufacturing. This company now owns all of the British Westinghouse common stock, which it is practically certain will in the not far distant future be a valuable asset. Good results are also expected to result from the new Russian company. In good circles the Westinghouse Electric preferred stock is regarded as having speculative possibilities surpassed by few stocks on the list. The stock now receives seven per cent dividends, but is entitled to share equally with the common in any advance above that rate. It also enjoys priority as to assets, but it is the possibility of dividends above seven per cent which is likely to receive speculative attention in the future."

The first flutter of financial sensitiveness over the Brooklyn Rapid Transit Company's announcement that it purposed floating a bond issue of $150,000,000 to provide for improvements in the property which, it is believed, will be needed in order to keep pace with the rapid growth of Brooklyn, has subsided to a great extent.

Boston:	Closing
Am. Telep. & Tel	157½
Edison Elec	254
Erie Tel	17
New Eng. Tel	140
Mass. Elec. pf	95½
Westing. Mfg. pf	89
Western Telephone & Telegraph	90

American Telephone and Telegraph new 4s are in good demand. This $10,000,000 issue was remarkably well placed, the greater portion in comparatively small lots for investment. It is figured that the normal market value of these bonds should be from 102 to 103, the very choicest state and municipal issues have a steady though not active market from a 3⅛ to a 2⅞ per cent basis.

Philadelphia:	Closing.
Elec. Co. of America	6⅛
Philadelphia Elec	3¾
Union Traction	37¼
United G. I. Co	118⅞
Elec. Stor. Bat. c	62
Elec. Stor. Bat. pf	65

At the annual meeting of the Bell Telephone Company of Philadelphia the directors were reelected, the only change being Jas. E. Mitchell elected president in place of Frederick P. Fish. It has been stated that a resolution was adopted at the meeting to provide for the calling of a special meeting of stockholders on April 22 for the purpose of authorizing an additional issue of $4,000,000 stock.

Chicago:	Closing.
Central Union Tel	40
Chicago Edison Light	165
Chicago Telep	185
Metropolitan El. pf	89¼
National Carbon	19
National Carbon pf	82
Union Traction	13¾
Union Traction pf	47

Carbon stocks attracted a great amount of attention, although in this case it was because of the weakness displayed. Heavy selling of Carbon common depressed the price of the stock below 19, caused by dividend not being declared. It is, however, expected later.

TELEPHONE AND TELEGRAPH

PASSAIC, N. J.—The Interstate Telephone Company has petitioned the council for a franchise to build a line in Garfield.

MONTGOMERY, ALA.—The city council has granted a franchise to a new independent company to operate in New Decatur, Ala.

MARION, IND.—The Central Union Telephone Company is rebuilding its plant and expects to have practically a new system in about six weeks.

ELKHART, IND.—The Home Telephone Company has successfully negotiated for a connection with the independent company of South Bend at the county line.

FAIRMOUNT, IND.—The United Telephone Company has purchased the Fairmount Telephone plant. The new company intends putting in new switchboards and new cables.

WICHITA, KAN.—The Missouri & Kansas Telephone Company is having great difficulty in putting its system in operation as the municipality is contesting its franchise right.

BUFFALO, N. Y.—The Frontier Telephone Company has filed with the city clerk a check for $10,000, and a formal notice that it has begun preparation of plans for construction of conduits.

SHENANDOAH, PA.—The United Telephone Company's new exchange at Altoona is nearly completed. Its line from Coatesville to Doe Run was opened January 1. The line from that point to West Grove is nearly completed.

GALESBURG, ILL.—The Galesburg Union Telephone Company has begun operating its new system in opposition to the Central Union. The company has now 800 subscribers, with a capacity of 3,000 telephones, and cost $100,000.

QUAKERTOWN, PA.—The extension of the Delaware & Atlantic Telephone line from Quakertown and Pennsburg is now an assured fact. The success met with in canvassing subscribers leaves no doubt as to its successful installation.

BILLINGS, MONT.—The old Yellowstone Valley telephone line and the Montana and Wyoming lines, extending from Red Lodge south, have been merged into one company under the latter name. The new company is capitalized at $40,000.

FREDERICK, MD.—A new telephone connection has been opened between Baltimore and Frederick, by a connection between the lines of the Frederick County Telephone and Telegraph Company, and the Maryland Telegraph Company, of Baltimore.

LONG POINT, ILL.—The Long Telephone Company met recently and arrangements were completed for building the line. The following officers have been selected: President, Frank Bosserman; secretary, Mahlon Harmon; treasurer, John Morgan.

KANSAS CITY, MO.—All the preliminaries connected with the deposit of the various bonds to ensure the construction of a new telephone plant have been arranged, and the company, the Kansas City Home Telephone Company, expects to start business with more subscribers than required by its bond.

LA CROSSE, WIS.—The Houston-Oak company will soon have direct connection with the telephone service of this city. It has been stated that the Houston company was already setting poles and stringing wires from its direct line to that of the Standard Telephone Company, of Iowa.

FORT DODGE, IOWA—The Fort Dodge Telephone Company and the E. H. Martin Company, of Webster City, have united, thus securing an increase in the territory covered by their toll service. It is announced that in the spring they will put in a new copper line from Fort Dodge to Des Moines.

TILTON, N. H.—G. Henry Davis has sold the Tilton & New Hampshire line, of which he was manager and principal owner, to the New England Telephone Company. This line has been connected with the Citizens' Telephone Company, giving free service to Sanbornton, North Sanbornton, New Hampton and Bristol.

INDUSTRIAL ITEMS

THE UNITED STATES CARBON COMPANY, Cleveland, Ohio, states that it has made some improvements in the character of its product and is preparing to increase its plant.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., manufactures a large line of coal handling machinery. Bulletin No. 002 gives a full description, sizes and prices.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, New York, N. Y., has ready its samples and prices for "Paragon" fans, season of 1902. Its water-tight floor outlet boxes are described in Bulletin 94, which will be sent upon request.

N. H. TREADWELL & COMPANY, New York city, manufactures the "Tread-kill" railroad car construction. This company is a successor to the Lebanon Manufacturing Company, and will be pleased to send full information upon request.

THE L. B. ALLEN COMPANY, INCORPORATED, 1335 Columbia avenue, Chicago, has recently completed an addition of three floors to its factory. This company manufactures the Allen compounds, among which are the "Allen Soldering Sticks," "Allen Flux," and "Allen Salts."

THE COUCH & SEELEY COMPANY, Boston, Mass., is manufacturing a new type of intercommunicating telephone, using an automatic button switch and an automatic reset, which may be used in the common return or with metallic circuit battery or magneto call.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY, Dayton, Ohio, has issued two splendid new catalogues. One is replete with illustrations and description of the Smith-Vaile power pumping machinery, and the other deals fully with the Stilwell heaters manufactured by this company.

THE BAIRD MANUFACTURING COMPANY, Chicago, Ill., is sending on request a circular describing the Baird automatic electric switch. Electric light producers, especially those who do contract lighting, should be sure to get one of these, as they describe fully this device.

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, Chicago, in its new line of telephone apparatus now being placed on the market is using a new switchboard key, which is said to have several advantages, and to be especially adapted for large multiple and trunking boards where the proper number of keys on a small key shelf is desirable.

SCHLESINGER & MEARS, 220 Broadway, New York, are placing on the market the new "S. & M." porcelain cleats for two or three-wire construction work, in either glazed or unglazed material. The company reports that through a special arrangement with a large porcelain manufacturer, it is able to offer these cleats in barrel lots at especially low prices.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, reports a very prosperous business the past season, during which time it has added to its line of manufacture a complete line of special lamps. The new type Buckeye lamp is in every way creditable to this institution, which has kept abreast in the development of the incandescent lamp from the earliest times.

THE DIEHL MANUFACTURING COMPANY, Elizabethport, N. J., is now ready to mail its 1902 catalogue of fan motor apparatus. This company maintains the following showrooms, 561 Broadway, New York; 192 Van Buren street, Chicago; 128 Essex street, Boston; 1217 Filbert street, Philadelphia; and in New Orleans is represented by Newman-Sprangley Company.

THE CUMBERLAND TELEPHONE AND TELEGRAPH COMPANY has issued a splendid souvenir containing the minutes of the twelfth annual banquet of the directors, officers, managers and other employés, given at Nashville, Tenn., December 27, 1901. The pamphlet contains the toasts and half-tones of the speakers, and is bound in a dark green cover illuminated with a silver punch-bowl.

PAUL M. LINCOLN, Niagara Falls, N. Y., is the manufacturer of the Lincoln synchronizer, a device of great advantage in the equipment of a station where alternators are run in parallel or where rotary converters or synchronous motors must be synchronized. A neat booklet describing this instrument and its application in detail will be sent upon application to the manufacturer.

THE STERLING ELECTRIC MANUFACTURING COMPANY, Warren, Ohio, manufactures the Sterling incandescent lamp. This lamp has a number of interesting features for which advantages are claimed over other types of incandescent lamps. The peculiarities of the lamp and especially its filaments were illustrated and described in these columns some weeks ago. Mr. Francis Granger represents this company in New York, with offices in the Havemeyer Building.

THE WYCKOFF PIPE AND CREOSOTING COMPANY, manufacturer of conduits and crossarms, has bought a large tract of ground at Norfolk, Va., where, with excellent shipping facilities both by rail and water, prompt attention may be given to the company's expanding business, which has entirely outgrown the facilities at Williamsport, Pa., and Moving Point, Va. The company is well known by all the leading telephone and telegraph companies, and has been supplying the same since the date of establishment of the conduit branch of the business in 1885.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has just completed and placed upon the market a complete line of drum controllers for printing-presses, cranes, hoists, machine tools, etc. These controllers are built in several different types, one very novel design embracing control through both armature and field of the motor, as well as no-voltage and overload release. Descriptive bulletins covering the above have been published and are being distributed. The company's business during the past year was double that of 1900, and it is constantly increasing facilities to keep up with the ever-growing demand.

THE ENGINEERS' CLUB, Scranton, Pa., at the annual meeting, January 23, 1902, elected the following officers for the ensuing year: President, H. H. Stoek; vice-president, B. F. La Rue, professor of civil engineering in the International Correspondence Schools; secretary, A. E. Lister; treasurer, F. J. Platt; corresponding secretary, A. B. Dunning; librarian, H. M. Lane, professor of mechanical engineering in the International Correspondence Schools; directors, W. M. Marple, C. C. Rose and H. W. Rowley. President Stoek is the able editor of *Mines and Minerals*, the well-known mining publication issued by the International Text-Book Company, Scranton, Pa.

THE NORTH-AMERICAN ACTINOLITE AND ASBESTITES COMPANY, Tottenville, S. I., is a company recently organized to market a new mineral product said to be excellent for insulating work, especially for the construction of switchboards. The material is known as Actinolite. Electrical and mechanical tests have been made of this product, and it is said to be found very good for electrical apparatus. One of the tests it is said was to subject this actinolite to a temperature of 3,500 degrees for a number of hours and when taken from the furnace was immediately plunged into cold water without injury. The officers of the company are: J. A. Bill, president and treasurer; Michael Seitz, secretary, and H. C. Harding, superintendent.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has just closed a contract with the Cass County Telephone Construction Company, of South Bend, Ind., for a central energy "Major Relay" type switchboard of 4,000 lines capacity, with a possibility of 7,200 lines. Its present capacity will consist of 1,500 lines. Included in this contract is all necessary power apparatus, arresters, frames, etc., and one hundred standard central energy telephones; a toll board of fifty lines capacity, with a present equipment of twenty-five lines. The company intends making this one of the most important toll lines in the West, giving service direct from Chicago to New York. At present the company will install 1,000 telephones, and additional instruments will be delivered as required.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, is actively engaged in preparing and installing a great number of railway and lighting batteries that are to be put into operation within the next few months. Among those from whom contracts have been secured are: The West Hampton Park Railway, at Richmond, Va.; the St. Albans Street Railway Company; the Indianapolis & Eastern Traction Company, Indianapolis; the San Juan & Santa Clara Railroad Company, San José, Cal.; the Trenton Street Railway Company, Trenton, N. J., on its Princeton division; the Chippewa Valley Electric Railroad Company, Eau Claire, Wis.; the Virginia Electric Railway and Development Company, Richmond, Va., making an aggregate of 1,768 cells, having an enormous ampere-hour capacity. Besides these the company has under construction a large number of contracts for small ampere-hour capacities.